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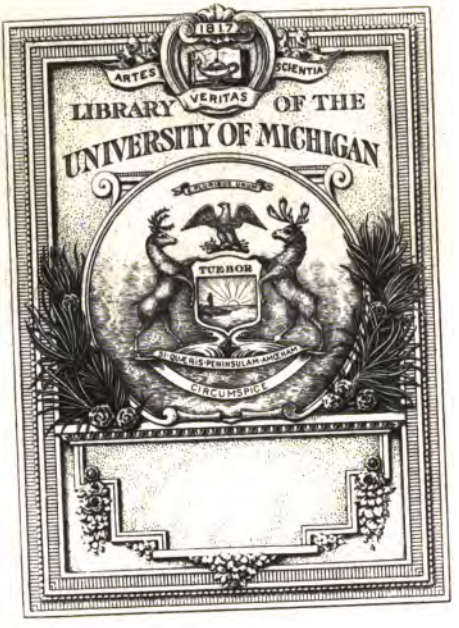
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PRELIMINARY REPORT

(54)

OF THE

GEOLOGICAL SURVEY

OF

KANSAS.

BY

G. C. SWALLOW,

STATE GEOLOGIST.

LAWRENCE, KANSAS:
JOHN SPEER, PRINTER TO THE STATE.
1866.

His Excellency, S. J. Crawford, Governor of Kansas—Sir:

In accordance with your instructions, I have made as thorough a geological reconnoissance of Eastern and Central Kansas, as the time and means at my disposal would permit; and I herewith transmit a preliminary report of the results of the survey, together with the report of C. A. Logan, M. D., on the sanitary relations of the State, the report of Tiffin Sinks, M. D., on the climatology of Kansas, and the geological report of Major F. Hawn. A special and full report on Miami county is also appended.

It has been our aim to give as brief and concise a view of the facts developed by the survey, and such obvious practical deductions as could be made in the few weeks devoted to making up the results, since the field work was closed. A more detailed statement of the results and economical deductions, will be given in a future report.

It gives us great pleasure to be able to report so many important developments from so hasty and incomplete an examination of the State. Other portions would doubtless give results equally satisfactory, and give to the whole of Kansas a reputation for agricultural and mineral resources far superior to what it has hitherto enjoyed.

In conclusion, allow me to express our lively appreciation of the courtesy and aid so freely rendered by yourself, whenever it would advance the good work assigned us; and permit us, sir, through you, to express to the people of Kansas our grateful acknowledgments of the sympathy and assistance we have everywhere received at their hands.

When so many have given us good reason to remember their services, it would seem impossible to mention names without making invidious distinctions; yet justice demands a recognition of such services as we received from the citizens of Miami county; from the Hon. G. A. Crawford, Major E. A. Smith, and others of Fort Scott; and from Gen. A. J. Mead and George Wisner, Esq., of Manhattan; S. D. Houston, Esq., of Junction City; A. B. Bartlett, Esq., and Col.

John M'Alpine, of Wyandotte. We are also under special obligations to Gen. H. S. Sleeper and Col. Edward Russell, for substantial aid, often repeated during the progress of the work, and to Col. D. E. Ballard for his efforts in our behalf. Drs. B. F. Shumard and Geo. Englemann have rendered us essential services in their departments of science.

The survey owes much of its efficiency and success to Drs. C. A. Logan and Tiffin Sinks, whose able and practical reports will do much to place Kansas in its true position before the world.

Major F. Hawn has given the survey the full benefit of his intimate and extensive knowledge of the State and its resources, and the collections made during his previous explorations, in connection with the lineal surveys of the General Government. His reports are full of scientific and practical information.

Very respectfully, your obedient servant,

G. C. SWALLOW.

LEAVENWORTH, January 8, 1866.

INTRODUCTION.

WHAT A GEOLOGICAL SURVEY SHOULD ACCOMPLISH.

A geological survey should determine:

1st. What rocks occupy the country, their relative position and thickness, to what *systems* and *formations* they belong in the geological series, and the areas occupied by each formation.

2d. It should determine the mineral and fossil contents of each formation.

3d. It should particularly describe and point out the characters and position of each rock and mineral deposit which may be useful in the economical and industrial pursuits of life.

4th. It should point out the value and uses to which each mineral deposit may be applied in the industrial arts.

5th. And suggest such improvements in mining and working the valuable rocks and minerals as the facts developed may indicate.

6th. As the soil is the most valuable of all the mineral formations, it should be particularly described, its varieties designated, and the adaptation of each to the staples of the country; and such improved modes of culture as the soils and climate and scientific deductions indicate as important, should be noted.

7th. The trees, shrubs and herbaceous plants should be examined, and their uses designated.

8th. *The climate should be investigated in its relations to health † and the industrial arts, particularly that of agriculture; as success in that more than in any other pursuit depends upon the weather.

To all of these particulars we have given our attention, and pushed our investigations as far as the time and means at our disposal would permit.

To the soils and climate,* in their relation to agriculture, we have given particular attention. So important is it to preserve our soils in their primitive richness, that the farmer should press into his service every deduction of experience or science to aid in securing the best possible results for his agricultural labors.

But some men are faithless as to any real *substantial aid* from scientific sources. Various causes have led practical men to this state of feeling. A few of the most important may well be examined.

1st. Many shallow men, incapable of success in any pursuit, who would be scientific, have become scientific quacks, and have, by a kind of brazen science, won their way to temporary favor. The contempt which all sensible and practical men must feel for such pretenders, has, to some extent, been exercised towards science itself.

2d. Many distinguished scientific men have never made any apparent practical use of the vast fund of scientific knowledge which they have acquired. Nor is it strange that men successful in interrogating Nature, should become so absorbed in the delightful pursuit, as to forget the many applications of their scientific knowledge by which human industry, wealth and happiness might be promoted.

3d. But the most prominent cause is, that science has not been rightly understood. Many have supposed it the mere theories, fine-spun from the imaginations of learned men, without any foundation in fact or experience; whereas, science, properly understood, is but a classification of all known facts—all the experience of all the past—so arranged and

* See Dr. Sinks' able report on our climate.

† This department is well presented in Dr. Logan's report.

classified as to manifest all those great principles which lie at the foundation of the practical pursuits of life.

We often hear that "Experience is more valuable than science." But science is the *very essence of all experience.*

But says one, "It is impossible to exhaust the inexhaustible soils of our glorious prairies." It may appear so at first, and for many years; but science and reason both conclusively show that the modes of cultivation usually adopted in the West, will gradually exhaust the soil, and impoverish the owner and the State. Many of the richest portions of the older States have long since known and felt the discouraging and demoralizing effects of exhausted soils and worn-out lands. And yet many of our farmers are so cultivating as to hasten the time when we shall have the same sad experience. Now, therefore, while the State is new, and the soil in its primitive vigor, every farmer should adopt such modes of culture as will not only preserve but increase the fertility of his lands.

While merchants and capitalists are exhausting all the resources of science to increase the profits of their investments; while physicians, and lawyers, and theologians, are founding schools to make their professions learned, skillful and powerful, and to give them the advantage of all the learning and experience of those who have gone before, and of all of every country who are now most successful, the farmers will do well to imitate their example, and adopt the best means of obtaining the knowledge and experience of the best farmers of all ages and countries; and found schools where their sons may be thoroughly educated and prepared for the duties of the husbandman.

Some may say, and even believe, "They want no *scientific agriculture*, no *book farming*." But if subsoil plowing will protect his crops from droughts and excessive rains, it matters not whether he learn that fact from books or the experience of his neighbors. If grape culture be more profitable than hemp, the results will be the same whether the art of cultivating the vineyard be learned in the Agricultural College at Manhattan, or among the vines and wine presses of our grape growers on the Missouri and the Ohio.

The sciences which should be taught in agricultural schools and books are the known facts discovered by the experience of all the farmers from Adam to the present day, and the principles and laws governing the mineral and vegetable kingdoms, and the climate, which have been discovered and applied by men of genuine science.

SECTION OF THE ROCKS IN EASTERN KANSAS.

SYSTEM I.—QUATERNARY.

FORMATION *a*.—ALLUVIUM.

No. 1.—Soil—everywhere, 1 to 6 feet.

No. 2.—Sand bars—Missouri and Kansas rivers, 10 to 20 feet.

No. 3.—River bottoms: Sands, clays, pebbles and vegetable mould or humus—all streams, 20 to 30 feet.

FORMATION *b*.—BOTTOM PRAIRIES.

No. 4.—Sands, clays and marls—large streams, 25 to 30 feet.

FORMATION *c*.—BLUFF.

No. 5.—Siliceous marls and sands—on all the highlands, under the soil, 1 to 150 feet.

FORMATION *d*.—DRIFT.

No. 6.—Sands, pebbles and boulders—generally distributed under the strata above named, and resting upon the consolidated strata below, 1 to 20 feet.

SYSTEM II.—TERTIARY.

In Western Kansas, but not yet examined.

SYSTEM III.—CRETACEOUS.

In Central Kansas—but partially examined.

No. 1.—Brown ferruginous yellow and buff sandstone; generally classed as cretaceous, but saw no proof of its age; hills south of Kansas river, near the mouth of the Saline, heads of Fancy and .Cottonwood; 295 feet.

SYSTEM IV.—TRIASSIC?

No. 2.—Brown, sandy shales and marls,* with thin beds of earthy carbonaceous matter, or impure coal, 15 feet. Locality, same as No. 1.

No. 3.—Brown, red, buff, gray and mottled sandstone, 75 feet. Locality, Republican, Smoky Hill, Cottonwood and Fancy creek.

No. 4.—Brown, drab and reddish marls and shales, 32 feet. Locality, same as No. 3.

No. 5.—Fine buff magnesian limestone in thin hard beds. *Nuculos* and *Bakevellias?* 6 feet. Locality, Kansas river and Fancy creek.

No. 6.—Red, brown, purple, blue and drab argillo—magnesian marls and shales, 50 to 90 feet. Some of these beds are intersected by thin calcareous plates crossing each other at angles nearly right, and forming a cancellated or chambered structure like the cancellated structure of bones, a hundred times magnified. The chambers, or cells, are filled with soft clay, and lined with crystals and concretions of lime. Locality, same as No. 3.

No. 7.—White, granular and dark gypsum and fibrous selenite, with marly shale partings, 42 feet. Locality, Kansas and Gypsum creek.

No. 8.—Red, blue, drab and purple marls and shales, 36 feet. Locality, same as No. 7.

No. 9.—White and colored gypsum, and selenite interstratified with various colored marls, 27 feet. Locality, Kansas river.

No. 10.†—Blueish and brownish drab shales and cancellated

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*A minute description of each stratum of the Triassic, Permian and Carboniferous systems of Kansas, was prepared, together with a full catalogue of the genera and species found in each; but it was found too voluminous for the objects of this report, and the following abstract was prepared.

†The sandstones, limestones, shales, marls and gypsums of Nos. 2—11 were referred to the Triassic with a (?) in 1853. The only evidence we then had of the age of these beds, was their position and lithological characters, and a single fossil which could not be distinguished from *Nucula Speciosa*, Munster, from the Muschelkalk of Bindloch. Subsequent examinations have strengthened the evidence we then had, that this is their true position. But still, the proof does not amount to a

marls, containing thin strata of gypsum and selenite, 35 feet. Locality, same as No. 9.

No. 11.—Fine, hard, porous, dark amber colored limestone, 1 foot. Locality, head of Turkey creek, Fancy and Cottonwood.

Total thickness of the Triassic strata, 338 feet.

SYSTEM V.—PERMIAN.

No. 12.—Blue, brown, purple and drab cancellated marls and shales, containing beds of gypsum and selenite, 30 to 40 feet. Locality, same as No. 11.

No. 13.—Fine hard buff and drab magnesian limestone in thin beds, *Nuculas* and *Bakvellias*, 5 feet. Locality, same as No. 11.

No. 14.—Brownish and blueish drab cancellated marls, 20 to 30 feet. Locality, Fancy and Turkey creeks and Cottonwood.

No. 15.—*Cancellated Limestone*, 3 to 10 feet. Similar in structure to the marls No. 6, *Bellerophons*. Locality, same as No. 14.

No. 16.—*Concretionary Limestone*, 2 to 15 feet. This is a yellowish-drab argillo-magnesian limestone in heavy concretionary beds. Locality, same as No. 14.

No. 17.—*Calcareous Conglomerate*, 1 to 24 feet. Not permanent. Locality, same as No. 16.

Nos. 15, 16 and 17 pass into each other by insensible gradations. They are not often found together, and all well developed.

No. 18.—Black porous rock, filled with fragments of fossil wood and other materials, 6 inches. Locality, Turkey creek.

No. 19.—Drab cancellated marls, interstratified with blue, green and purple shales, 8 to 40 feet. Locality, same as No. 14.

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demonstration, and the true relations of these rocks must remain in doubt, till other discoveries determine the matter. Our present knowledge is sufficient for all practical purposes; for we know their exact position in the series of rocks in Kansas, and their valuable mineral contents, and the places where the gypsum beds may be found.

No. 20.—Grayish buff *Cellular Limestone*, 2 feet. Locality, Fancy creek.

No. 21.—Blueish shale, 2 feet. Locality, same as No. 20.

No. 22.—Hard brown-buff cellular limestone, 4 inches.

No. 23.—Blueish-drab shale, with calcareous concretions, 3 feet.

No. 24.—Fine blueish-drab and buff magnesian limestone, full of Permian *Acephala* and *Cephalopods*, 6 inches. Locality, Fancy and Turkey creeks, and Cottonwood.

No. 25.—Marly shales, 1 to 5 feet. Locality, same as No. 24.

No. 26.—Hard grayish and blueish-buff porous oolitic limestone, full of minute *Acephala* of Permian types, 1 to 2 feet. Locality, same as No. 24.

No. 27.—Brownish-buff magnesian limestone, 6 to 12 inches. Fossils same as last. Locality, same as No. 24.

No. 28.—Brown sandy shales, filled with *Aviculopecten Coustans*, 6 inches. Locality, same as No. 24.

No. 29.—Blue and brown shales, *Circulopecten Coustans*, 6 to 12 feet. Locality, same as No. 24.

No. 30.—Buff magnesian limestone, 6 inches. Locality, same as No. 24.

Total thickness of the Permian strata, 141 feet 1 inch.

LOWER PERMIAN.

No. 31.—Brown, red and blue shales, 3 to 20 feet. Numerous *Producti*, *Orthisina*, *Athyris*, *Stenopora*, *Crinoids* and *Cynoclodia biscialis*. Locality, same as No. 24.

No. 32.—Soft impure brown porous magnesian limestone, 6 to 8 inches. Locality, same as No. 24.

No. 33.—Blue and drab marls, 1 to 15 feet. Locality, Turkey and Fancy creeks.

No. 34.—Hard blue and dark buff limestone, *Productus, Calhounianus*, *Edmondia Hawni*, *Monotis Hawni*, *Myalina* and *Pinna*, 1 to 2 feet. Locality, same as No. 33.

No. 35.—Blue and brown marls, 1 to 2 feet. Sometimes cherty. Locality, same as No. 33.

No. 36.—Blue and brown hard or soft limestone, 1 foot.

Locality, same as No. 33. *Monotis*, *Schizodus*, *Bakevellias* and *Pinna*, etc.

No. 37.—Shales, 7 inches. Locality, Turkey creek.

No. 38.—Hard yellowish-drab magnesian limestone, with dark spots and dentritic markings, 1 foot. *Monotis*, *Pecten*, *Schizodus*, *Avicula*, etc. Locality, same as No. 37.

No. 39.—Blue and brown, green and red shales and marls, 30 to 40 feet. Many fossils; nearly all carboniferous genera. Locality, Cottonwood, Carey and Fancy creeks.

No. 40.—1st. *Cherty Limestone;* is a brownish-buff magnesian limestone, with cherty concretions, 4 feet. *Productus Calhounianus*, *semireticulatus? Athyris subtilita? Archaeocidaris.* Locality, Cottonwood and Carey creek.

No. 41.—Brown and drab indurated marls with chalcedonic geodes. Locality, same as No. 40.

No. 42.—Buff and blueish-gray and brown coarse porous magnesian limestone, showing sun-cracks and ripple marks, 4 to 12 feet. *Archaeocidaris Orthisina*, *Synocladia*, *Crinoids* and *Balanus?* Locality, same as No. 40.

No. 43.—Brown and blue marls, 12 feet. Fossils and locality, same as No. 40.

No. 44.—2d. *Cherty Limestone;* is hard, blueish drab, and very cherty, 4 feet. *Productus*, *Myalina* and *Spirifer.* Locality, same as No. 40.

No. 45.—Brown marls, 8 feet. Fossils and locality, same as No. 40.

No. 46.—Brown and buff cellular limestone, 1 foot 6 inches. Locality, same as No. 40.

No. 47.—Brown, blue, purple and green shales and marls, 42 feet. *Archaeocidaris*, *Athyris* and *Crinoids.* Locality, same as No. 48.

No. 48.—Blueish bluff and brown magnesian limestone. Permian *acephala*, 13 feet. Locality, Carey and Fancy creeks.

No. 49.—Brown, blue, green and drab marls and shales, with thin beds of limestone. Locality, Carey creek.

No. 50.—Drab and buff magnesian limestone. Permian fossils. Locality, same as No. 49.

No. 51.—Blue and brown shales and marls. *Athyris* like *subtilita*. Locality, same as No. 49.

No. 52.—*Fort Riley limestone.* This is a buff, porous magnesian rock, in thick beds. *Productus, Calhounianus, Orthisina, Shumardiana, Archaeocidaris, Bakevellia,* etc., 8 to 10 feet. Locality, near Fort Riley, Cottonwood and Fancy Creek.

No. 53.—Blue and brown shales, 6 feet. Locality and fossils same as 52.

No. 54.—3d. *Cherty Limestone;* is light buff and magnesian, 40 feet. *Productus Calhounianus, Archæocidaris, Spirifer*, like *lineatus, Orthisena* like *umbraculum*, etc. Locality, same as No. 52.

No. 55—Brown, blue and red shales and marls, 35 feet. Locality and fossils, same as No. 54.

No. 56.—*Myalina Limestone*; is a hard, firm brownish-gray and buff magnesian limestone. Numerous *myalinas* of Permian forms, 4 to 8 feet. Locality, same as No. 52.

No. 57—Blue, brown and red marls and shales, 10 to 25 feet. Locality and fossils, same as No. 52.

No. 58.—4th. *Cherty Limestone*; is brown and buff, porous and cherty magnesian limestone, 10 to 24 feet. Locality and fossils, nearly the same as No. 54.

No. 59.—Blue and drab and brown marls and shales, 8 to 21 feet. *Orthis, Chonetes, Arca* and *Crinoids.* Locality, same as No. 52.

No. 60.—Thin sandy argillo, calcareous shales, full of Permian *Acephala*, 3 feet. Locality, near Fort Riley.

No. 61.—Blueish-brown shales. *Chonetes* and *Productus*, 3 feet. Locality, same as No. 60.

No. 62—5th. *Cherty Limestone;* is a light drab and buff cherty magnesian limestone, 12 feet. *Productus Calhounianus, Chonetes Mucronata, Orhisena* like *umbraculum, Athyris* like *subtita* and *Crinoids.* Locality, same as No. 60.

No. 63.—Brown, blueish, drab, green and purple shales and marls, 11 to 23 feet. *Synocladia biserialis*, *Productus Norwodi*, *Orthisena Shumardiana*, etc. Locality, same as No. 60.

No. 64.—Impure, brown, porous limestone, with dark dots and dendritic markings, 4 feet. Locality, same as No. 60.

No. 65.—Blue and brown marls and shales, 15 to 30 feet. Locality, same as No. 60.

No. 66.—Light buff and drab argillo, magnesian limestone, in their beds with dark dendritic markings, 15 to 18 feet. *Monotis* and *Bakevellia*. Locality, same as No. 60.

No. 67.—Blue and drab shales and marls, 6 feet. Locality, same as No. 60.

No. 68—Hard blue and buff magnesian limestone, containing numerous Permian *Acephala*, 1 to 3 feet. Locality, Cottonwood and Clark's creek.

No. 69.—Drab shaley marls, 5 feet.

No. 70.—Hard blue and drab, mottled porous limestone, 1 to 6 feet.

No. 71.—Brown, blue and reddish marls, 6 feet. Locality, Clark's creek.

No. 72.—Blueish-gray limestone, 3 inches. Locality, Clark's creek.

No. 73.—Brown or purple mottled shales, 7 feet.

No. 74.—Hard brown and blue limestone, 10 inches.

No. 75.—Blue shales, 6 inches.

No. 76.—Soft blue and gray coraline limestone, 3 feet. Locality, Cottonwood and Clark's creek. *Monotis Halli*, and *Americana*, *Productus Norwoodi*, *Synocladia biserialis*, *Thamniscus deebius? Edmondia Hardni*, *Phillipsia Cliftoncusis*, etc.

No. 77.—Blue, brown and purple shale and marls, 9 feet. Locality, same as No. 76.

No. 78.—Gray and drab porous limestone, 2 feet. Locality, same as No. 76.

No. 79.—Blue, brown and purple marls some very much

cancellated, and a few beds of thin limestone, 38 feet. *Chonetes, Productus, Costatoides, Orthisena Missouriensis and umbraculum? and Synocladia, and Archaeocidaris and Euomphalus.* Locality, same as No 76.

No. 80.—*Fusulina* Limestone, 6 feet. Buff, porous and magnesian. *Productus, Chonetes, Allorisma, Fusulina.* Locality, Manhattan, Cottonwood Falls and Mill creek.

No. 81.—Blue, brown, purple and green shales and marls, with calcareous concretions and thin consolidated strata, 31 feet. *Monotis, Edmondia, Myalina, Pecten, Allorisma,* and *Bellerophon*; nearly all Permian types.

No. 82—*Cotton Rock,* 5 feet. A light cream-colored argillo-magnesian limestone; sometimes in thin beds, with shale partings. It has numerous dendritic markings. *Spirifer, Athyris, Fusulina, Productus* and *Crinoids.* Locality, Manhattan and Mill creek.

No. 83.—Blueish brown marls, 1 foot.

No. 84.—*Dry bone* Limestone, brown concretionary and cancellated limestone, 5 feet. *Synocladia biserialis, Spirifer plano-convexa,* etc. Locality, same as 82.

Nos. 82, 83 and 84 are sometimes represented by a blueish-gray and buff, porous magnesian limestone; upper beds thick below; thin beds separated by cellular partings, containing numerous Permian *Acephala* and *Zaphrentis* and small *Spirifer.* Locality, Cottonwood.

Total thickness Lower Permian Strata, 563 feet.

Total Permian Strata, 704 feet and one inch.

SYSTEM VI.—CARBONIFEROUS.

FORMATION *a*.—COAL MEASURES.

UPPER COAL SERIES.

No. 85.—Brown indurated and cancellated marls, 2 feet 6 inches. *Spirifer plano-convexa* and *cameratus, Fusulina,* etc. Locality, Manhattan.

No. 86.—Hard buff and gray limestone, filled with fragments of fossils, 1 foot 3 inches. Locality, same as No. 85.

No. 87.—Buff and brown and blue marls and shales, 8 feet.

No. 88.—Impure, soft, brown and buff argillo-magnesian limestone, 5 feet. Locality, same as No. 85.

No. 89.—Brown shaly marl, 1 foot.

No. 90.—Blue and brown mottled limestone, 1 foot.

No. 91.—Brown and drab, green and purple marls and shales, 19 feet. *Retzia* PUNCTILIFORA, *Monotis* and *Edmondia.*

No. 92.—Fine drab magnesian limestone, 10 inches.

No. 93.—Blue, green, drab, brown and purple shales and marls, and sandy shales near the top, and black slate near bottom, 38 feet. *Athyris subtitita, Archaeocidaris aculeatus.* Locality, same as No. 85.

No. 94.—Brown sandy shales, 6 feet. Locality, same as No. 85.

No. 95.—Brown calcareous sandstone, with crystals of calc spar, 3 to 4 feet. Locality, Manhattan.

No. 96.—*Fulsulina Shales*, 12 feet. Dark blue marley shale; numerous carboniferous *Brachiopoda.* Locality, Manhattan, Cottonwood and Mill creek.

No. 97.—Black slate, 1 foot. *Fish scales* and *Discina Missouriensis.*

No. 98.—Coal, 1 to 3 inches. Locality, Manhattan and Mill creek.

No. 99.—Impure brown limestone, 1 foot. *Fish teeth.*

No. 100.—Blue and brown shales, 5 feet.

No. 102.—Impure buff magnesian limestone; many *Fusilinas*, 1 foot.

No. 103.—Blue, brown and purple shales, 25 feet.

No. 104.—Hard blue limestone, 1 foot. *Productus* and *Crinoids.*

No. 105.—Black, brown and blue shales, 2 feet.

No. 106.—Impure blueish-brown limestone, 10 inches. Hydraulic. *Productus, Chonetes, Spirifer* and *Orthisina.*

No. 107.—Blue, brown and purple marls and shales; some sandy shales in the strata, 35 to 43 feet. Locality, same as No. 98.

No. 108.—Hard, drab, blueish and porous magnesian limestone, 2 feet to 3 feet 6 inches. *Permian Acephala.*

No. 109.—Drab, blue and greenish marls, often filled or re-

placed by black, white, buff and yellow selenite, 1 foot 6 inches. Locality, same as No. 98.

No. 110.—Impure dark brown shaly limestone, 6 inches. *Carboniferous fossils.*

No. 111.—Dark blue and drab shales, 2 feet.

No. 112.—Impure shaly limestone, 10 inches. *Fucoids.*

No. 113.—Blue shale, 1 foot.

No. 114.—Coal, 1 to 3 inches.

No. 115.—Blue shale, 2 feet 6 inches.

No. 116.—Oxide of iron, 3 inches. Locality, Mill creek.

No. 117.—Impure brown magnesian limestone, 1 foot.

No. 118.—Blue and brown argillo-arenaceous shales and marls, 17 feet. Locality, same as No. 98.

No. 119.—Blue and brown impure limestone (Hydraulic) 1 foot 3 inches.

No. 120.—Blue, brown and black shales, 9 feet.

No. 121.—Blue and drab magnesian marls, containing crystals of black selenite, 15 feet. Numerous *Acephala* and *Cepholopoda.* Some like Permian types. Locality, Zeandale and Mill creek.

No. 122.—Hard crystalline grayish-blue limestone, with black dots and dendritic markings, 2 to 10 inches. Numerous small *Acephala* and *Cephalopoda.* Some like Permian types. Locality, same as No. 121.

No. 123.—Blue, drab and brown magnesian shales, 6 feet. Fossils and locality, same as No. 121.

No. 124.—Hard fine reddish-brown and gray spotted limestone, 2 feet.

No. 125.—Drab, blue and brown grayish shales, 4 to 6 feet.

No. 126.—Buff and brown soft argillo-calcareous sandstone, 1 foot 8 inches. The lower part is calcario-magnesian, full of chocolate-colored pores, and small masses of oxide of iron. Colors and pores arranged in thin strata, which separate on exposure. Locality, Mill creek.

No. 127.—Green, drab and purple shale, 12 feet.

No. 128.—Impure brown porous limestone, and greenish-drab porous marls, 1 foot 6 inches to 2 feet. *Productus,*

Retzia, *Spirifer*, *Orthisena*, etc. Locality, same as No. 121.

No. 129.—Blue, brown and purple shales and marls, 33 feet. Fossils and locality, same as No. 121.

No. 130.—Coal, 4 to 10 inches.

No. 131.—Fire clay, 6 inches.

No. 132.—Brown and blue sandstone and shale, 21 feet. Locality, Mill creek.

No. 133.—Impure brown and greenish-gray hydraulic limestone, 1 foot 3 inches. *Productus*, *Chonetes*, *Pinna* and *Fusulina*. Locality, same as No. 132.

No. 134.—Blue argillaceous and sandy shales, 6 feet.

No. 135.—*Chaetetes Limestone*, 6 feet. This is a fine, hard porous impure limestone, varying in color from gray through ochreous-brown to chocolate. The lower part is firm and brown, and the upper beds are blue and argillaceous. *Fusulina*, *Myalina*, *Zaphrentis*, *Crinoids* and *Chaetetes* in irregular masses, or formed around a Zaphrentis or Crinoid column. Locality, Mill creek and eastward.

No. 136.—Brown and blue shales and marls, with calcareous concretions and bands of kidney ore, 45 feet. Locality, same as No. 135.

No. 137.—Brown and blueish-gray limestone, in one bed, 1 foot 8 inches. *Chonetes* and *Crinoids*.

No. 138.—Blue and brown shales, 10 feet.

No. 139.—Hard dark-brown ochreous limestone, 2 feet. Locality, near Baptist Mission.

No. 140.—Shale, 5 feet. Locality, same as No. 139.

Total thickness Upper Coal series, 391 feet 1 inch.

CHOCOLATE LIMESTONE SERIES.

No. 141.—*Chocolate Limestone*, 6 feet. This is a coarse, rough, porous gray and chocolate limestone, full of a very large, ventricose *Fusulina; Productus Americanus*, *Calhounianus* and *Cora*, *Zaphrentis* and *Crinoids*. Locality, Mill creek and eastward.

No. 142.—Blue and brown sandy shales, 11 feet. Fossils and locality, same as No. 134.

No. 143.—Thin brown impure limestone and calcareous sandstones, with shale partings, 8 feet. Locality, Verdigris Falls and west of Baptist Mission.

No. 144.—Purple and blue shales, 18 feet. Locality, same as No. 143.

No. 145.—Brown micaceous sandstone, 3 feet.

No. 146.—Blue, drab, red and gray limestone, passing into sandstone, 8 feet. Numerous *Corals* and *Brachiopoda*.

No. 147.—Brown shales, 3 feet.

No. 148.—Bituminous shales, 4 feet.

No. 149.—Gray, buff and brown limestone, passing into brown sandstone below, in some places, 9 feet. Numerous *Corals* and *Brachiopoda*.

No. 150.—Brown shales and sandstones, 9 feet. Numerous *Corals* and *Brachiopoda*.

Total thickness Chocolate Limestone series, 79 feet.

STANTON LIMESTONE SERIES.

No. 151.—*Stanton Limestone*, 6 to 28 feet. Rather coarse, drab magnesian and brown limestone. *Productus Americanus*, *Athyris Subtilita* and *Archaeocidaris*, etc. Locality, Mission creek, Marais des Cygnes and Verdigris.

No. 152.—Argillaceous shales and sandstones, 8 feet. Locality, Marais des Cygnes and Verdigris.

No. 153.—Blue pyritiferous shales, 9 feet. Locality, Verdigris.

No. 154.—Bituminous coal, 1 foot to 2 feet 6 inches. Locality, Marais des Cygnes and Verdigris.

No. 155.—Gray and brown sandstone and shales, 12 to 60 feet. Locality, same as No. 154.

Total thickness Stanton Limestone series, 74 feet.

CAVE ROCK SERIES.

No. 156.—*Cave Limestone*, 15 to 30 feet. Blueish-gray and brown jointed limestone, with marly partings, in places. *Spirifer hemiplicata*, *Productus*, *Athyris*,

Crinoids, etc. Locality, Beaver and Sugar creeks, and at Topeka.

No. 157.—*Einstein Sandstone;* is a blue, brown and gray sandstone and shale, 45 to 60 feet. Locality, same as No. 156.

Total thickness Cave Rock series, 75 feet.

SPRING ROCK SERIES.

No. 158.—Gray limestone, spotted with brown, in thin irregular beds, 2 feet. Locality, same as No. 156.

No. 159.—Sandstone and shales, 15 to 25 feet. Locality, same as No. 156.

No. 160.—Coal, 4 to 8 inches. Locality, Bull and Middle creeks, Miami county.

No. 161.—Fire clay, 4 feet. Locality, same as No. 160.

Nos. 159, 160 and 161 are often replaced by a blueish-brown shale, filled with calcareous concretions.

No. 162.—*Spring Rock;* is a hard blueish-gray and brown limestone, 2 feet 8 inches to 4 feet. Locality, Beaver creek, Marais des Cygnes, and Johnson's coal-bed, west of Topeka, and Lecompton.

No. 163.—Brown sandstones and blue shales, interstratified, 4 to 38 feet. Locality, same as No. 162.

No. 164.—Bituminous coal, 6 inches to 1 foot 6 inches. Locality, west of Baptist Mission, at Johnson's coal-bed, west of Topeka.

No. 165.—Fire clay, 1 foot. Locality, same as No. 162.

No. 166.—Blue shales and brown sandstones, and bands of kidney ore, 35 feet. Locality, west of Baptist Mission, at Lecompton and Beaver creek.

Total thickness Spring Rock series, 88 feet 2 inches.

WELL ROCK SERIES.

No. 167.—Blue and gray limestone, and porous chert, in thin beds, interstratified with shales, 5 to 7 feet. *Spirifer*, *Productus*, *Athyris*, etc. Locality, Lecompton, Middle creek and Marais des Cygnes.

No. 168.—Blue shales, 13 feet. Locality, same as No. 167.

No. 169.—*Well Rock*, 10 to 48 feet. Light-gray and hard brown limestone, with cherty concretions. When fully developed, the upper part is coarse and porous, in heavy beds. Numerous corals and *Brachiopoda*. Locality, Paris, Garnett, Ottawa, Leavenworth and Sugar creek.

No. 170.—Brown and blue shales, and fine blueish-gray limestone, interstratified, (in places all shale,) 2 to 6 feet. *Productus*, *Chonetes*, *Spirifer*, *Corals* and *Crinoids*. Locality, same as No. 169.

No. 171.—Bituminous shale, 6 feet 6 inches. *Discina* and *Turbo*. Locality, same as No. 169.

No. 172.—Hard, fine blue limestone, 1 foot 3 inches to 3 feet. *Spirifer lineatus*. Locality, same as No. 169.

No. 173.—Blue and brown shales, 1 to 4 feet. Locality, same as No. 169.

No. 174.—Brown and gray cherty limestone, with shale partings, 10 to 15 feet. Numerous corals and *Brachiopoda*. Locality, same as No. 169.

No. 175.—Blue and brown shales, and brown and gray shales and sandstones, with bands of iron ore, 75 to 100 feet. Locality, same as No. 169.

No. 176.—Bituminous coal, 1 to 5 inches. Locality, Center creek, west of Lawrence.

No. 177.—Brown, green and purple shales and marls, and buff and gray sandstones, 55 to 90 feet. Locality, same as No. 169.

Total thickness Well Rock series, 238 feet 6 inches.

MARAIS DES CYGNES COAL SERIES.

No. 178.—Hard, firm blue limestone, with jointed structure, 2 to 4 feet. *Spirifer lineatus*, *Athyris subtilita* and *Crinoids*. Locality, Sugar and Mine creeks, Linn county.

No. 179.—Brown sandstones and blue shales, and bands of iron ore, 38 to 51 feet. Locality, same as No. 178.

No. 180.—Bituminous coal, 2 inches. Locality, same as No. 178.

No. 181.—Blue and black shale, 3 feet. Locality, same as No. 178.

No. 182.—Bituminous coal, 1 foot 8 inches to 2 feet 9 inches. Locality, same as No. 178.

No. 183.—Black shale and fire clay, 3 feet. Locality, Linn county.

No. 184.—Impure brown and blueish-gray limestone, 6 feet. *Spirifer*, *Productus*, *Chonetes*, *Myalina*, *Pecten*, etc. Locality, Sugar creek and Lawrence.

No. 185.—Buff and brown, regularly stratified, sandstone, 45 feet. Locality, Muddy creek, Linn county.

No. 186.—Blue shales and marls, 25 feet. Locality, Mound City and Muddy creek.

No. 187.—Brown and blueish-gray limestone, with shale partings and numerous fossils, 12 feet. Locality, same as No. 186.

No. 188.—Blue and brown shaly marls, 2 feet. Locality, Marais des Cygnes and Mine creek.

No. 189.—Fine blueish-drab concretionary limestone, 4 feet. Locality, same as No. 188.

No. 190.—Brown and blueish sandstone and shales,* 45 feet. Locality, same as No. 188.

No. 191.—Coal, 1 foot to 2 feet 6 inches. Locality, same as No. 188.

No. 192.—Black slate and fire clay, 2 feet.

No. 193.—Blueish-drab compact limestone, with very large masses *Chaetetes*, 5 feet. Locality, Marais des Cygnes and Indian creek.

No. 194.—Brown and drab shales, containing numerous calcareous concretions, 15 feet. Locality, Mill creek, in Bourbon county.

No. 195.—Blue, green, brown and chocolate shales and marls, 30 feet. Locality, same as No. 194.

No. 196.—Sandy shales, 10 feet. Locality, same as No. 194.

No. 197.—Brown and dull brownish-drab sandstone, in regu-

* Mine creek lead mines are in these rocks.

lar beds, 11 feet. *Calamites.* Locality, same as No. 194.

No. 198.—Brown and drab sandy shales, 8 feet. Locality, same as No. 194.

No. 199.—Blue shales, with bands of kidney ore, 17 feet.

No. 200.—Bituminous and pyritiferous shale, 1 foot.

Nos. 194 and 200 are represented by 45 feet of blue and brown shales, with bands of kidney ore on the Marais des Cygnes, at Root's coal bed.

No. 201.—Coal, 2 to 3 feet. Locality, same as No. 194, and Marais des Cygnes, and at Mound City.

No. 202.—Fine clays and shales, 5 feet.

Total Marais des Cygnes Coal Series, 303 feet and 4 inches.

Some of the strata may be duplicated in this series, as they are very much disturbed where the sections were made.

PAWNEE LIMESTONE SERIES.

No. 203.—*Pawnee Limestone*;* is heavy bedded, porous and compact, coarse and fine, drab, brown and blueish-gray, cherty, concretionary and mottled, 20 to 25 feet. *Chaetetes, Crinoids,* etc. Locality, Indian and Pawnee creeks, and south to Bone creek.

No. 204.—Dull brownish-blue hydraulic concretionary limestone, with pyritiferous shale partings, 6 feet. Locality, same as No. 203.

No. 205.—Black slate, 2 to 4 feet. *Discinas.* Locality, same as No. 204.

No. 206.—Blue and brown argillo-sandy shales, 5 feet. Locality, on the Marmaton, above Fort Scott, and Indian creek.

No. 207.—Impure black shaly limestone, full of fossils, and bed of *cone-in-cone*, 6 feet. Locality, same as No. 206.

* The lower part of this limestone is almost exactly like the Fort Scott Limestone, both in lithological characters and fossils; hence it is very difficult to distinguish them when the upper gray beds of this limestone and the shales below are not exposed. Between Indian creek and the Marmaton, both of these rocks crop out in the numerous ravines and slopes, and they are very much broken and disturbed, making it almost impossible to make a correct section between those streams, without this knowledge of the similarity of these limestones.

No. 208.—Blue and brown argillo-sandy shales, with thin bands of brown limestone and septaria of iron ore, 34 feet. Locality, Indian and Wolverine creek.

No. 209.—Black, impure shaly limestone, full of fossils, 1 foot. *Spirifer*, *Productus* and *Chonetes*. Locality, same as No. 206.

No. 210.—Coal and coal smut, 6 inches. Locality, same as No. 206.

No. 211.—Brown and blue argillo-sandy shales, with a few bands of iron ore, 25 feet.

Total Pawnee Limestone Series, 112 feet and 6 inches.

FORT SCOTT COAL SERIES.

No. 212.—*Fort Scott Limestone;* is a blueish-drab and brown, irregularly bedded limestone, with many *Producti*, *Chonetes*, *Spirifers*, etc., 8 to 18 feet. Locality, Little Osage, Fort Scott, and south to the Drywood and Bone creek, and west to the Neosho.

No. 213.—Dark-brown shales and marlites and iron-stone, 2 feet. Locality, same as No. 212.

No. 214.—Black slate, 4 feet 6 inches. Locality, same as No. 212.

No. 215.—Coal, 6 inches. Locality, same as No. 212.

No. 216.—Gray, blue and brown fire-clays and shales, 5 to 8 feet.

No. 217.—Impure brown and drab hydraulic concretionary limestone, in one thick bed, 6 feet. *Productus*, *Spirifer*, *Crinoids*, etc. Locality, same as 212.

No. 218.—Black slate, containing large concretions of iron-stone, 4 feet.

No. 219.—Coal, 1 foot 4 inches. Locality, same as 212.

No. 220.—Fire-clay, 4 feet.

No. 221.—Impure brown mottled limestone, 2 feet. *Spirifer* like *Cameratus*, but new. Locality, only on Drywood.

No. 222.—Drab and blueish fire-clays, 12 feet. This bed often passes into sand-stone or sandy shales. Locality, same as No. 212.

No. 223.—Blue, brown and drab argillo-sandy shales and sandstones, with numerous beds of good iron ore, 87 feet. Locality, same as No. 212.

Total Fort Scott Coal Series, 142 feet and 10 inches.

FORT SCOTT MARBLE SERIES.

No. 224.—Hard, fine, black limestone, 3 feet. Locality, Little Osage, near State line.

No. 225.—Black slate, 5 feet. Locality, same as No. 224.

No. 226.—Blue and yellow shale, 7 feet. Locality, same as No. 224.

No. 227.—*Fort Scott Marble;* is black, with numerous yellowish veins and crystalized shells, and it weathers brown. It takes a good polish, 1 foot 6 inches. Locality, Slick Rock Ford, on the Marmaton, and on Moor's Branch, above the Military Ford.

No. 228.—Blue and brown shales, 1 foot 8 inches.

No. 229.—Black slate, 2 feet. Locality, same as No. 227.

No. 230.—Coal, good, 2 feet 6 inches. Locality, Little Osage, below State line.

Total Fort Scott Marble Series, 22 feet 8 inches.

LOWER COAL SERIES.*

No. 231.—Long slope to Middle Fork of Cow creek, probably sandstone and shale, and two beds of coal 1 and 2 feet in thickness, 25 to 50 feet.

No. 232.—Brown sandstone and sandy shales and iron ore, 10 feet, Locality, Dorsey's, on Middle Fork Cow creek.

No. 233.—Brown and blueish argillo-sandy shales with dark partings. Locality, same as No. 232.

* The Southeastern part of the State, the only place where the lower coal rocks come to the surface, is so level, and the slopes are so gentle, and the soft shales and sandstones are so abundant, that the rocks are but rarely exposed; and the exposures are so small and so far from each other, that it is very difficult to make a connected section with absolute certainty. We could expect to make only an approximation to a connected section in the few days devoted to this interesting region. But whenever any uncertainty exists in the rocks or their connections, it is fully indicated in the text. If more time could be devoted to this region, a connected section could doubtless be made of this important part of the Coal Series.

No. 234.—Bituminous coal,* 5 to 7 feet. Locality, Dorsey's coal bank.

No. 235.—Slope on East Fork or Little Cow creek, 10? feet.

No. 236.—Hard brown and gray sandstone, in thick beds and jointed structure, and shale partings, 20 feet. Locality, same as No. 235.

No. 237.—Sandy and argillaceous shales, 10 feet.

No. 238.—Coal and Smut, 2 to 6 inches.

No. 239.—Shales and sandstone, 5 feet. Locality, Military Ford, on Cow creek.

No. 240.—Red and brown shales, with kidney ore, 20 feet. Locality, Shawnee creek.

No. 241.—Brown, hard, ripple-marked sandstone, with shale partings, 9 feet. Locality, Brush creek and Mound, six miles west of Baxter's Springs.

No. 242.—Blue and brown shales, with black partings and numerous beds of iron ore, 35 feet. Locality, same as No. 241.

No. 243.—Coal and coal smut, 2 to 4 inches. Locality, same as No. 241.

No. 244.—Blue and brown shales, 50 feet. Locality, same as No. 241.

No. 245.—Slope, probably sandstone and shales, 20 to 30 feet.

No. 246.—Brown micaceous sandstone; some irregular, thick soft beds, and some shale partings below, 40 feet. *Calamites.* Locality, Neosho, 3 to 5 miles above State line.

No. 247.—Coal, but partially seen; probably same as the three foot bed on branch of Cow creek, west of the Military Ford, 3? feet. Locality, same as No. 246.

No. 248.—Gray and brown sandstone and kidney ore, 2 feet. Locality, on the Neosho, at the State line, and 3 miles above.

No. 249.—Blue shales with black partings, and many bands of iron ore, of which hundreds of tons are washed

* We saw but four feet of this coal, as the bank was caved in, but it is reported to be seven or eight feet thick in places.

out here, 12 feet 2 inches. Locality, same as No. 248.

No. 250.—Black and gray calcareous shaly limestone, full of fossils, 8 inches. *Productus*, *Chonetes*, *Orthisina*, *Spirifer*, *Corals*, *Crinoids*, etc. Locality, same as No. 248.

No. 251.—Blue and black shale, 2 feet. Locality, same as No. 248.

No. 252.—Coal, 6 to 10 inches. Locality, same as No. 248.

No. 253.—Blue, brown and black shales, 17 feet.

No. 254.—Space in which the rocks were not seen, 25? feet.

Total Lower Coal Series, 353 feet.

Total thickness Coal Measures in Southern Kansas, 2,000 feet.

FORMATION c.—LOWER CARBONIFEROUS.

No. 255.—Slope, covered by fragments of chert and cherty ferruginous conglomerate and clays, 10 feet. Locality, Baxter's Springs and Branch.

No. 256.—Gray and blueish-gray crystalline and granular limestone, with intercallations of chert and hornstone, 110 feet. *Spirifer*, *Productus*, *Chonetes*, *Platycrinus* and *Zaphrentis*. Locality, Baxter's Springs and Branch, to Spring river.

Total Lower Carboniferous, 120 feet.

GEOLOGY OF KANSAS.

On account of the Indian troubles on our western border our labors have been confined to the eastern part of the State. This report will, therefore, be devoted to the Geology of Eastern Kansas, to which will be added such facts respecting the Western part of the State as have been obtained from reliable sources.

Previous to 1853, it was generally supposed that the rocks of the eastern border of Kansas and Nebraska, and Western Iowa and Missouri, belonged to the Lower Carboniferous System, which, in this country, is entirely destitute of the regular productive coal beds; and indeed, this vast region, on the line dividing these four States, along the valley of the Missouri and the Kansas, and southward to the Osage, had been reported destitute of coal, and so represented on the maps of the country.

But in that year, while engaged in the survey of Missouri, it was my good fortune to prove the rocks* of Southeastern Nebraska, Southwestern Iowa and Western Missouri and Eastern Kansas, as far south as Branch creek, to be the true *coal measures*; and that the whole of this vast region is underlaid by productive coal beds.

In 1857, Maj. F. Hawn collected a series of specimens from which we were enabled to prove a large portion of Central Kansas underlaid by rocks of the Triassic? and Permian Systems,† the true salt and gypsum-bearing strata of Europe, and the first of that age identified in this country.

*Second annual report on Geological Survey of Missouri, pp. 78 and 82.

†Transactions of the Academy of Science, St. Louis, 1858, Vol. 1, No. 2.

The vast amount of coal in the coal measures of Eastern Kansas, and the inexhaustible deposits of gypsum and salt, in the central part of the State, are of the first importance to the political, commercial and social interests of the people. It has therefore, been our special aim to develop these vast sources of wealth and prosperity.

The rocks of Kansas belong to six geological systems, as shown in the foregoing section of the strata.

SYSTEM I.—QUATERNARY.

This system includes the *drift*, and all the formations above it, all the deposits comprised in the alluvion and diluvion of former geologists.

There are within this period four distinct and well marked formations in this State:

F. a—ALLUVIUM. *F. c*—BLUFF.
F. b—BOTTOM PRAIRIE. *F. d*—DRIFT.

These comprise all our surface deposits, all the loose clays, marls, sands, soils, humus and mould, found upon the surface of our State; all of which have been formed in a period very recent in the geological cycles; all that have been formed since the present order of things commenced upon our continent are included in—

FORMATION *a*.—ALLUVIUM.

All the deposits observed in the State, belonging to this formation, are:

1ST. SOILS. 4TH. VEGETABLE MOULD OR HUMUS.
2D. PEBBLES AND SAND. 5TH. BOG IRON ORE.
3D. CLAYS. 6TH. CALCAREOUS TUFA.
7TH. STALACTITES AND STALAGMITES.

1st. *Soils* are a well-known mixture of various comminuted and decomposed mineral substances, combined and mingled with decayed vegetable and animal remains, all comprising those ingredients peculiarly adapted to the nourishment of the vegetable kingdom. They are formed by the action of water, (particularly in the form of rain and dews,) cold, heat and other atmospheric influences, together with the co-operation of the vegetable and animal kingdoms.

The process by which soils are formed, is one of the most

beautiful and wonderful in nature. By a careful examination of what is transpiring in this great laboratory of nature, we may easily detect that process. If a rock, fresh from the quarry, be exposed, its surface will soon present a dull, earthy appearance, which is caused by a disintegration of its surface by atmospheric influences. Fine particles have been separated from the mass, and this meager coating of decomposing mineral matter will soon become the resting place of numerous microscopic germs, which will be developed into a minute growth of lichens. These, in turn, will decay, and add their remains to the pulverized particles, and prepare them to sustain a more vigorous growth of herbs, and to become the abode of the small insects and worms which will burrow in their recesses, feed upon the increasing vegetation, and swell the mass, both by their mechanical agency, and by adding their exuviæ to the accumulating soil. Larger plants and animals will accelerate the process by their more powerful agencies, and by the greater amount contributed by their decaying remains. Thus, by almost imperceptible increments, our rich, deep soils have been accumulated.

These facts clearly show the influence of the rocks upon the character of the soils formed by their disintegration. Hence, soils resting upon sandstones, are light and sandy; those upon limestones, are calcareous; and those on shales, wet and clayey. But the varieties of soils will be more fully noticed under the head of Economical Geology.

2d. *Pebbles and Sand.*—Many of our streams abound in water-worn pebbles, which constitute their beds, and form bars along their margins and across their channels. These pebbles were derived from the drift and the harder portions of the adjacent rocks. They vary in size, according to the transporting power of the stream in which they are found.

The economical value of these pebbles and gravel for roads and streets, and the obstructions the sands often present to navigation on the Missouri and the Kansas, and the injury produced upon farms* when those streams overflow them,

* In the flood of 1844, so much sand was deposited on several farms on the Missouri as to entirely ruin them for agricultural purposes. They have since grown up with cottonwood and sycamores.

give to these deposits an unusual importance in our geology.

Sand is the most abundant material in the alluvial bottoms of the great rivers in the State. Vast quantities of it are constantly borne along by the irresistible current of the Missouri. Its whirling, rolling, turbulent waters form from it extensive bars in incredibly short periods, which they again wear away, often still more rapidly than they were formed.

These sand bars, so common in this stream, frequently extend along its bed several miles, with a breadth varying from one to five or six furlongs, and limited in thickness only by the depth of the water. A slight fall in the river leaves these vast sand beds dry, when their surfaces are soon covered by a growth of weeds, interspersed with young willows and cottonwoods. The fickle stream, however, seldom leaves these sand beds to a long repose; but returns to its old channel by a rapid removal of their loose materials.

At high stages of water, both the Missouri and Kansas overflow their low bottoms, and leave deposits of a grayish-brown, or a grayish-yellow sand, similar to that in the sand bars mentioned above.

The thickness of these beds depends upon the height and continuance of the overflowing waters, varying from a mere perceptible stratum to several feet.

That from the flood of 1844 is very conspicuous throughout the length of the Missouri and Kansas bottoms in this State. It is sometimes six or eight feet thick, particularly in low bottoms, so heavily timbered as to obstruct the current.

These sands are nearly all silex, but they contain enough calcareous, argillaceous and vegetable matter to render them fertile, as is abundantly proved by the growth of weeds and willows, cottonwoods and sycamores, which immediately spring up on these sandbars whenever they are exposed above the water. There are many points on the Missouri, as in the bottom at the mouth of the Kansas, where a thrifty growth of young timber may be seen on the sand deposited by the high waters in 1844.

3d. *Clays.*—These are dark blueish-gray argillaceous strata, rendered more or less impure by fine siliceous, calcareous and decomposed organic matter. When the floods of the Missou-

ri, the Kansas, the Neosho and other streams subside, the lagoons, lakes and sloughs in their bottoms are left full of turbid waters. The coarser materials soon settle and form, with what was deposited during the high water, a bed of sand; but the finer particles subside more gradually, and form the silico-calcareous clays of these alluvial bottoms. Thus, by each succeeding flood and period of low water, new strata of sand and clays are deposited, until the lakes and sloughs are filled up. The thickness of each stratum of sand depends upon the length and violence of the floods, but that of the clays is governed more by the time between the periods of high waters.

These alternations of sands and clays may be observed in all the alluvial bottoms of our great rivers, where the waters have cut through these strata. The following section, near the mouth of the Kansas, is a good illustration of these recent deposits:

No. 1.—1 foot, dark soil.
No. 2.—1½ foot, river sand.
No. 3.—1 foot, vegetable mould and dark clay.
No. 4.—1½ foot, river sand.
No. 5.—2 feet, blueish, marly clay.
No. 6.—6 feet, buff river sand.
No. 7.—1½ foot, marly clays and river sand, interstratified.
No. 8.—10 feet, coarser and purer buff colored sands.

This bed presents various and irregular stratifications.

4th. *Vegetable Mould*, or *Humus*, is a dark brown or black deposit of decayed vegetable matter, containing variable, though small, quantities of fine siliceous and argillaceous particles. When wet, it is very soft and plastic, and quite black; but when dry, it separates into angular cuboidal fragments, which readily crumble into a dark brown, very light, impalpable powder.

The process by which these strata of humus are deposited is very obvious. When the lakes and sloughs of these bottoms are so far filled up as to sustain vegetable life, the decay of the annual growth, and of the foreign matter which falls or floats into these waters, forms a stratum of humus at the bottom, over the beds of clay and sand previously deposited by the floods and still waters. Another overflow gives an-

other succession of sand and clay; and the succeeding annual crop of vegetable matter, another stratum of humus.

These changes have often continued until several series of these deposits were formed. But when the bottoms of these bodies of water had been thus raised so high above the river that the floods less frequently flowed into them, the deposit of sand diminished, and the long, quiet intervals, favored the deposition of clay and humus. In time these shallow waters became mere marshes, where a rank vegetation rapidly formed thick beds of vegetable mould for the support of the magnificent forests which now occupy the sites of those former lakes and sloughs.

Such is the process by which a large part of the vast and rich alluvial bottoms bordering our rivers have been deposited.

There are numerous shallow lakes in these bottoms, in which vast quantities of marly humus are accumulating, which will eventually become very valuable for the improvement of poor or exhausted soils.

The rich and productive powers of this formation are abundantly proved by the immense border of timber and the rank prairie grasses it sustains, and the rich crops it yields to the labors of the husbandman.

5th. *Bog Iron Ore* is formed in small quantities, from springs of calybeate waters at innumerable localities. It has a yellowish-brown color, and it often forms a thin crust or pellicle* on the water, which exhibits the irised colors of the rainbow.

6th. *Calcareous Tufa* is found in numerous places in the State. Where lime waters flow over the rocks and soils and evaporate, the lime is deposited as a light-colored coating, or a thick porous bed, covering up and preserving fragments of rocks and animal and vegetable remains. Deposits of Tufa are often seen on the face of limestone slopes and bluffs, containing beautiful specimens of mosses and lichens in a state of perfect preservation.

These tufas are usually formed of carbonate of lime; but

*These irised colored pellicles are often mistaken for petroleum; but they can be easily distinguished, for they break into angular fragments when the waters are disturbed, and when collected, will not ignite.

where the rocks are magnesian, they are composed of the carbonates of lime and magnesia, colored more or less buff and brown by iron and other impurities.

There is an important deposit of tufa on Mill creek, near Buffalo Mound, which might be mistaken for an ancient permian-breccia; as it contains numerous angular fragments of magnesian limestone of the Permian period.

7th. *Stalactites* and *Stalagmites* are found in limited quantities only, as we have but few extensive caves favorable to their formation.

Range and Thickness.—The Alluvium of Kansas is co-extensive with the State; as it comprises all the soils and other deposits now forming. It is, however, much more abundant in the valleys of our large streams; where the thickness is often 30 to 40 feet, though generally much less.

Organic Remains, all belong to existing species.

FORMATION 6.—BOTTOM PRAIRIE.

As the beds of humus, clays, marls and sands, which constitute the extensive formation on which our bottom prairies rest, was found distinct from all other formations and without a name, I venture to call it *Bottom Prairie.**

This important formation is very similar to the *Alluvial Bottoms* above described, and has usually been confounded with them; but the proof† is conclusive that it was formed at an earlier period, and under circumstances very different from those now existing.

The character of the deposits in this Formation is well exhibited in the following section from the prairie bottom above Atchison:

No. 1.—3 feet, soil.
No. 2.—5 feet, sandy loam.
No. 3.—8 feet, marly clays and sand, interstratified.
No. 4.—5 feet, blue, marly clays, with iron stains.
No. 5.—2 feet, fine, gray sand.
No. 6.—3 feet, marly blue clay.
Water of the river.

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*See Second Annual Report of the Missouri Survey, pp. 66 and 68.

†See Second Annual Report of the Missouri Survey, pp. 66 and 67, and Sec. 2, p. 63.

The strata composing this Formation vary more or less at different localities.

Range and Thickness.—The Bottom Prairie was, doubtless, co-extensive with the bottoms of our principal streams, and was formed by agencies operating over the whole area occupied by these bottoms; but the subsequent action of the rivers has been constantly cutting it away, forming new channels, and filling up the old ones with the silt and drift of the Alluvial Bottom. It may be seen in the banks of all our large streams where they cut through the bottom prairies. It sometimes reaches a thickness of 35 feet.

Organic Remains.—Numerous species of *Helix*, *Succinea*, *Planorbis*, *Physa*, *Limnea*, *Pupa* and *Valvata* have been found in it; and many remains of trees, shrubs and vines have also been collected, but not yet identified.

In an economical point of view this is one of the most important formations in the State; as it underlies nearly all our bottom prairies and forms the basis of their superior soils.

FORMATION c.—BLUFF.

This formation rests upon and is therefore more recent than the Drift. It also runs under* the Bottom Prairie, and is consequently older than that series of our rocks.

When well developed, it usually presents a fine pulverulent, obsoletely stratified mass of light grayish-buff, siliceous and slightly indurated marl. Its color is usually variegated with deeper brown stains of oxide of iron.

The Bluff is well developed in the northeastern part of the State, and is well exposed at Leavenworth, Wyandotte, Lawrence and Atchison, in the cuts made in grading the streets, and in the excavations made at the brick-yards and at other places.

When but sparingly developed its composition and color is more variable; as it is then more affected by the subjacent rocks. When over the purple shales and marls of the Coal Measures and Permian System, it has a much darker color; as seen on the Kansas, at the mouth of Turkey creek and

*See figure 4, p. 67, Second Annual Report Missouri Survey.

bove Gypsum creek. But when it lies upon the light-drab arls of the same systems, it is light-buff or grayish. And hen over sandstone, it is arenaceous; as near St. George, in Osowatomie county.

In some places the ferruginous and calcareous matter increases, and we find concretions of marl and iron-stone, either isseminated through the mass or arranged in horizontal belts; t other places it has more arenaceous matter, and is much nore decidedly stratified.

This formation is often penetrated in all directions by numerous tubes of calcareous clay-iron stone and small holes, aused* probably by roots of trees and other plants, as they ften penetrate this formation to a great depth. These tubes nd holes often constitute a most thorough system of under rainage.

An analysis of this bluff or marl, gave from 100 parts ried at 212 deg. F.:

Silica,	77.02
Alumina and peroxide of iron,	11.05
Lime,	3.25
Potassa,	1.05
Magnesia,	1.63
Soda,	Trace.
Carbonic Acid,	2.88
Water,	2.43
Loss,	74
	100.00

This analysis and the physical structure of the Bluff marls prove them to be fine, light, rich siliceous marls, all that could be desired to form the basis of our soils.

Range and Thickness.—The Bluff is well developed along he bluff of the Missouri and the Kansas, and underlies the soils in nearly all the country between the Missouri and the Blue, north of the Kansas, and south to the divide between the waters of the Missouri and the Arkansas. It is also found south of this divide, and west of the Blue; but there it is not so well developed, and it exhibits less of its usual properties and influences over the formation of the soils.

It sometimes attains to a thickness of 150 feet. It is 100

* See Second Annual Report Geological Survey of Missouri, pp. 70 and 71.

feet at Wyandotte, and 75 feet at Leavenworth. It has attained its greatest development in the northeastern counties, and thins out to the south and west.

Organic Remains.—The fossils of the Bluff Formation are very numerous and interesting. Those I have had time to identify are of the Mammalia, two teeth of the *Elephos primigenius*, *Mastodon giganteus*, the jaw-bone of the *Castor fiber Americana*, the molar of a *Ruminant*, and the incisor of a *Rodent;* of the Mollusca, seventeen species of the genus *Helix*, eight *Linnea*, eight *Physa*, three *Pupa*, four *Planorbis*, six *Succinea*, and one each of the genera *Valvata*, *Amnicola*, *Helicina* and *Cyclas*, besides some others not determined. These *lacustrine*, *fluviatile*, *amphibious* and *land* species, indicate a deposit formed in a fresh-water lake, surrounded by land and fed by rivers. These facts carry back the mind to a time when a large portion of this great valley was covered by a vast lake, into which from the surrounding land flowed various rivers and smaller streams. We see the waters peopled with numerous Mollusks; the industrious beaver building his habitation; the nimble squirrel, the fleet deer, the sedate elephant, and huge mastodon, lords of the soil. There must have been land to sustain the elephant, and mastodon, and Helices; fresh water and land for the beaver; and fresh water for the Cyclas and Linneas.

Some years since I proposed the title *Bluff Formation* for this deposit, as it forms a large portion of, and gives the peculiar character to, the bluffs so conspicuous and unique in the scenery about Council Bluffs* and other portions of the Missouri valley; and as it forms the tops of the bluffs wherever it is developed.

Loess, the name of a similar formation on the Rhine, has been given to this by some geologists.† But this would imply that these two formations are identical, when they may or may not be, so far as any proof has been given.

FORMATION d.—DRIFT.

This formation lies immediately below the marls of the

*See Second Annual Report Missouri Survey, p. 75, and Plates I. and II.

†Lyell's Elementary Geology, p. 122.

luff on the high lands, and beneath the strata of the Bottom 'rairie on the bottoms. It consists of three distinct divisions n Kansas:

1st. What may be called an *Altered Drift*, are beds of uff and brown sands and small pebbles, which appear to e the finer materials of the drift, removed and rearranged by queous agencies subsequent to the drift period, and prior o the formation of the bluff. The pebbles are from all the varities of rocks found in the true drift, but are comparatively small.

These stratified sands may be seen under the *Bottom Prairie*, near the mouth of the Kansas, and under the marls of the bluff, in the brick yard below the bridge at Lawrence, and in many other localities.

2d. The *Boulder Formation*, as it was left disturbed by those powerful and and widely extended agencies which formed that deposit of the Northern Hemisphere. It is a heterogeneous stratum of sand, gravel and boulders, all water-worn fragments of the older rocks. The larger part are from the Igneous and Matamorphic rocks, in place at the North, and the remainder from the limestone strata, upon which they rest.

The large boulders—sometimes ten feet in diameter—so often seen scattered over the prairies in the northern part of the State, belong to this division of the drift. They are very abundant on the high ridges east of Wabaunsee.

3d. *Local Drift.*—This division is made up of pebbles of flint and other hard portions of the consolidated strata beneath.

The materials are usually very much worn and deposited in irregular beds on the consolidated rocks below the surface clays, marls and sands of the formations already described. The small streams often cut through these beds and leave them exposed in the banks, where they appear very much like alluvial pebbles in the beds of water courses.

Range and Thickness.—The Boulder Formation, or regular Drift, is best developed in Northeastern Kansas, where it is sometimes ten or fifteen feet thick. It does not extend much south of the Kansas river.

Organic Remains are very rare in these deposits. We

have seen none, but a few trees in the *Altered Drift* in the banks of the Missouri.

TERTIARY SYSTEM.

The rocks of this system are known to occupy a considerable portion of Western Kansas; but we have had no opportunity of examining these formations, and therefore cannot give any detailed description of them. The most important fact known respecting this series of rocks, is that it contains extensive beds of *brown coal* or *lignite*, which must be very valuable for fuel in a region possessing so little timber.*

They crop out along the Smoky Hill, and render that beautiful valley most desirable for agriculture, railroads and manufactures; whereas, without these beds of fuel, this valley must have remained but sparingly populated for centuries to come.

CRETACEOUS SYSTEM.

Also underlies a large portion of Central Kansas. The ferruginous sandstones which cap the hills and ridges in Central Kansas, have been referred to this system, whether correctly so must be determined by the examination of localities beyond the range of our explorations during the past year. The cretaceous rocks, however, are known to exist in considerable force in Central Kansas.

TRIASSIC? SYSTEM.

There is a series of buff, red and mottled sandstones, red and drab marls, buff, magnesian and black limestones, blue and brown shales, thin beds of black carbonaceous matter, and gypsum, 344 feet in thickness, under the sandstone of the Cretaceous and over the rocks known to be Permian.

As a sufficient number of fossils had not been found in these strata to fully decide the exact age to which they belong, and as they resembled in lithological and palæontological characters the Triassic rocks of Europe more than any others,

* For a description of these liguites, see chapter on coal.

they were placed provisionally in that group by Maj. Hawn and myself, in 1858, and as no fossils have been found since, it is not deemed advisable* to make any change in the arrangement until future discoveries shall fully establish their position in the geological ages.

It should be remembered, however, that the uncertainty about the age of these rocks does not in the least interfere with our fully understanding the mineral wealth contained in them, nor with our ability to fully develop it, for we know the exact position of these rocks† in the series, the strata of which they are made up, the valuable minerals they contain, and their wonderful fertilizing influence over the soils which rest upon them or come within the range of the waters that flow from them.

These rocks extend in an irregular belt across the State from the head-waters of the Blue and Fancy, across the Republican and Solomon, and over the Kansas between Turkey creek and the Saline; thence south and southeasterly up the Smoky Hill and Gypsum, Holland and Turkey creeks, along the northern slope of the divide south of the Kansas, to the heads of Lyon and Dimond creeks; sweeping thence westward across the Cottonwood and down the divide south of that stream, to the Walnut and Whitewater.

The gypsum beds in this formation are variable in thickness, ranging from 0 to 50 feet. Deposits of pure white gypsum crop out on the Blue, the Republican, the Kansas, and on Turkey creek, and on the divides between the Gypsum and Holland, and between Turkey creek and the Cottonwood. The beds at the four last localities are very thick, and miles in length. There are doubtless many other localities

*The red, buff and mottled sandstones, the red, drab, greenish, blue and gray marls and shales, the buff magnesian and black limestones, the beds, white and dark, of gypsums, and the thin beds of black, impure carbonaceous matter, are so very similar to the Triassic rocks of England, France and Germany, that one can scarcely walk over them without being constantly impressed with the idea that they belong to the same age. And besides, the few imperfect organic remains found in these rocks are more like the fossils of the Trias than any other. They contain a *nucula* so like the *species* of Munster, from the Muschelkalk of Bindlock, that no marks of distinction can be discovered. These facts, though not conclusive proof of the age of these strata, induce us to leave them in the Trias until further evidence is brought to light.

†See above section Nos. 2—10.

within the range of these rocks where these gypsums come to the surface, which a more careful examination will develop.

PERMIAN SYSTEM.

There is a series of limestones, marls, shales, sandstones, conglomerates and gypsums below the Triassic group described above, which belong to the same age as the Permian rocks of Europe. Since the true position of these rocks was first announced* in 1858, the proofs of their identity with the Permian System has been constantly accumulating, until, at the present time, there is probably no Geologist who has examined the matter and still doubts their identity with the Permian of Europe.

UPPER PERMIAN.

We have made two divisions of these rocks, in reference to the fossils they contain. The upper division comprise the limestones, marls, shales, conglomerate, sandstones and gypsums in Nos. 12–80 of the section above, representing a thickness of 146 feet. The fossils of these strata, so far as observed, belonging in the main to the *Acephala* and *Cephalopoda* and *Gasteropoda*,† and no one of them has been identified with known carboniferous species.

In lithological characters, these rocks are very similar to the rocks of the same age in Europe. The magnesian limestones and conglomerates, the various colored marls and shales, and the gypsums, all and each, would well answer the descriptions given of the same rocks in England and Germany. These rocks occupy a narrow belt across the State east of the Triassic group as described above. They also contain beds of gypsum, which, together with the marls found in all parts of the series, have a most beneficial influence upon the soils, and will, to a great extent, control the productions, population and wealth of Central Kansas.

*This discovery was first announced by myself February 22, 1858. See Trans. Acad. Nat. Sci., St. Louis, Vol. I.

†A complete and full section of all the Triassic, Permian and Carboniferous rocks of Kansas has been made, which, together with a catalogue of the fossils in each stratum, will soon be ready for publication.

LOWER PERMIAN.

This series, like the Upper Permian, is made up of a succession of magnesian limestones, blue, drab and green marls, and shales, red and buff sandstones and conglomerates and gypsums, but there are more blue shales like those in the coal measures below. These rocks contain nearly or quite all the fossils found in the Upper Permian, and in addition, a few species* common to the Upper Coal Measures, and perhaps a very few not found above or below.

It is a remarkable fact that the Permian and Carboniferous types are seldom, if ever, mingled in the same stratum, though both occur in their beds alternating with each other. The Carboniferous forms usually occur in blue argillaceous shales, and in the blue limestones, and the Permian in the magnesian and sandy limestones, and drab magnesian shales and marls.

The character of the fossils follows the lithological characters of the rocks in which they occur; so, whenever the rocks are of a carboniferous character, we may expect to find fossils of carboniferous types, and when the rocks are of a Permian character, the fossils are also Permian.

The magnesian material and Permian fossils increase towards the south. They are much more abundant on the Cottonwood than on the Kansas, and the blue shales and carboniferous fossils are not so fully developed on the former stream.

A large number of these strata exhibit indications of shoal water in the sun-cracks, ripple-marks and small piles of fossils and fragments washed together on their surfaces.

These Permian strata so graduate into, and are so nearly conformable to the coal measures below, that no want of conformability can be detected by examining any one locality, though the line of junction be traced a long distance. Yet when sections are made across the line of junction at distant

*In 1858, I expressed the opinion, based upon the collections sent me by Maj. Hawn, that "although the Permian *species* are so much more numerous, the Carboniferous *specimens* are much the more abundant." But, after a personal examination of the rocks, I am fully satisfied that the Permian forms are by far the most numerous, even in the lowest strata.

points, it becomes evident that there is a striking non-conformability. When the sections made across this line on the Kansas, at Manhattan, and above, are compared with those on the Blue, though separated several miles, there is no difficulty in identifying all the important strata in one with those in the others; and when these sections are compared with those on Mill creek, some 25 miles east, and those on the Cottonwood, 60 miles south from Manhattan, the prominent beds are easily identified down to the lowest bed of the Permian, No. 84 of the above section, but Nos. 85–95, from the sections near Manhattan are not found in the Mill creek sections, where No. 84 rests directly upon the Fusulina shales No. 96.

These facts present a striking illustration in our geology of Prof. Sedgwick's remarks on the Permian of England:

"Through many large tracts of country * * * it," (the magnesian limestone,) "rests on the coal measures, and seems to partake of their dip and inclination. It is, therefore, only after an extensive comparison of the two formations that we can make out their general want of conformity."—*Ge. Trans. Vol.* 3, *2d Se., p.* 56.

In another paper:

"Again, though the lower red sandstone" of Yorkshire and Durham "appears in some cases to graduate into the coal measures, * * * yet when considered on a great scale, it is unconformable to them, and on that account was separated from them."—*Ge. Trans. 2d Se. Vol.* 4, *p.* 397.

These extracts express the facts as they exist in Kansas, and give one good reason why the line of separation should be made where it is. But the main reason for the separation here is the fact that the permian fossils come down in force to this line, and but few go below, while a few species only of carboniferous fossils are found above it; but in the shales immediately below, there are at least thirty species and millions of specimens.

The rocks also change in lithological characters, the blue shales increase, the limestones are less magnesian and more argillaceous and ferruginous,* dark, nearly black fossiliferous,

* The magnesian limestones weather white, while the ferruginous became brown on exposure. This change in the color of the surface limestones is very obvious to one passing over the line between these formations. One traveling from the Missouri to Manhattan, on the north side of the Kaw, or to the hills east of Wabaunsee, on the south, over the coal measures, will find nearly all the limestones brownish,

argillo-shaley limestones, and their bands of spathic iron come in; bituminous shales and their coal beds begin to appear, and the marls and limestones and shales below no longer present the marked cancellated structure so characteristic of those rocks above. These facts clearly indicate the line of division between the Permian and Carboniferous systems.

CARBONIFEROUS SYSTEM.

COAL MEASURES.

This formation occupies the surface of nearly all Kansas, east of the eastern boundary of the Permian rocks (an area of over 17,000 square miles). This boundary crosses the State in an irregular line from a point on the northern border near the 96th parallel, near Manhattan and Emporia, and thence south across the head waters of the Verdigris and Fall river.

The Coal Measures are made up of numerous limestones and sandstones, shales and marls, spathic iron, fire clay and coal, Nos. 85–254 of the above section. These strata lie in a position nearly horizontal with numerous undulations and a slight general dip to the west, showing no signs of local disturbances, save in a few localities. The most important ones observed were between the Marais des Cygnes and Fort Scott, where the strata are often fractured and tilted up by some forces not now in action.

The lowest of these strata come to the surface in the southeast, and as the country rises to the northwest, the higher beds successively crop out, resting upon those below, until they reach a thickness of 2,000 feet,* as measured along the

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but at those points he will find those in the tops of the hills white, and nearly all between these points and the Triassic sandstones near Salina, of the same color. The same facts may be observed on the Blue, on Mill creek, on the Cottonwood and the Verdigris. These changes are so obvious, that men unacquainted with geology have observed and mentioned them.

*Though this is the measured thickness of the Coal Strata, they will not be found so thick at any given point, for in the east, some of the upper beds are watery, and, in the west, when all are present, they are not so thick as their outcrops where the measurements were made.

They cover the surface over an area of 17,000 square miles, and then run beneath the Permian rocks westward, how far no one knows.

outcropping edges. The relative position of these strata may be well illustrated by the courses of shingles on a roof, only the lower shingles should be long enough to reach the ridge-pole under the upper layers; as do the lower rocks in their western extension. Like the shingles, the higher strata crop out as the country rises to the west.

Nearly all the important beds of limestone become thicker towards the south and east,* where they come to and occupy the surface. Towards the west and north these limestones are hard, subcrystalline, blueish-gray or brown, and cherty, and this part of these beds remains very persistent; while they are made thicker by the addition of higher massive beds of coarse gray and buff porous and magnesian limestones, more or less stained with iron, especially in the pores. These upper beds usually appear as if made up in part of small fragments of fossils and other calcareous matter. They also contain fossils which run through this portion of all the limestones thus thickened, and are more abundant in them than elsewhere, or even in the lower portions of the same formations. Two or three species of *Archeocidaris* and a large *Athyris* are abundant; and *Productus Americanus* is more rare in these beds.

The sandstones and sandy shales are also thicker towards the southeast, and are more generally irregular than any others of these formations; old beds thinning out and new ones coming in between the more persistent and regular strata of shales and limestones.

These characteristics are so common to the upper beds of so many of the limestones, that it is very difficult† to distin-

* As an illustration: The thickness of the *Well Rock* No. 169, is only 10 feet at the ferry near Lecompton, while on Sugar creek, in Anderson county, it is 48 feet. The thickness of the *Stanton Limestone*, No. 151, is only 6 feet at Baptist Mission, in Shawnee county, but on the Marais des Cygnes, in Miami county, it is 18 feet.

† The difficulty of this work will be better appreciated when it is remembered there are 80 separate and distinct limestones in the Coal Measures, and many of them almost counterparts of each other in both universal characters and fossil contents; and yet the geologist, to do his work correctly, must be able to distinguish each of them from any one of all the others; and that, too, wherever it may crop out, or under whichever of its numerous forms; whether as a six foot or a thirty foot bed; whether a few inches of it only appears above the surface, or the whole formation; or whether it exhibits those fossils only which are common to a score of other similar rocks. But to fully comprehend this matter, one should attempt to

guish these beds from each other, and keep the true position of each throughout the vast extent of country over which some of them come to the surface.

The *Well Rock* crops out on Sugar creek, in Anderson county, as a coarse, gray, rough limestone, 48 feet thick. At the ford of the Marais des Cygnes, on the "Telegraph road," it is a fine, drab, compact limestone, 8 feet thick, with an entire new set of fossils. Thence it may be traced from stream to stream and slope to slope, till found near high water mark at Lecompton, and in the tops of the ridges at Lawrence. This last position it holds in the ridges to Leavenworth, where it is blueish-gray and brown, and subcrystalline. Thence it continues cutting ridge and valley to Wolf river and the northern border of the State.

These coal beds are also thicker towards the south and east, though there are exceptions. But the most important irregularity observed, is the want of persistence or continuity in these beds.

Along the eastern border of this vast coal field,* the coal beds are much more persistent. As a general rule, the southeastern portion of a coal bed is more persistent than the northwestern, and the lower beds more so than the upper ones. This is one of the reasons why the coal is so abundant and can be mined with so much certainty along the eastern outcrop of the lower beds, extending from Fort Gibson to Forts Smith and Scott, and thence across the Osage through Bates, Johnson and Saline counties, in Missouri, and through Boone, Howard, Randolph and up the Chariton valley into Iowa. Everywhere along this line shafts can be sunk upon the lower coal beds with an almost absolute certainty of success. But further west, and along the outcrop of the upper beds, mining operations for coal will be much more precarious. The geol-

follow up one of these limestones from valley to valley and ridge to ridge, throughout the hundreds of miles where it comes to the surface from time to time in the slopes and ravines.

* This coal field occupies a large part of the Indian Territory south, all Eastern Kansas, the northwestern half of Missouri, Southern Iowa and Southeastern Nebraska. Its western boundary extends from a point west of Council Bluffs, in an irregular line, into Kansas, and thence through Manhattan and Emporia, and south to the Verdigris and Fall river.

ogist can tell with certainty where the rocks containing each coal bed can be found, and at about what depth, but this irregularity or want of persistence renders it somewhat uncertain whether the coal will be found in its usual place.

But this slight variation from the usual characters in our coal beds will not much diminish the vast quantity of coal in the State, or render them less important in an economical point of view.

As given in the section of the Coal Measures, we have discovered 22 different beds, varying in thickness from a few inches to 7 feet.

Beds of *Carbonate of Iron*, *Spathic Iron* or *Kidney Ore* are abundant in the middle and lower portions of this formation.

An examination of the section will show the position of the numerous beds of hydraulic limestone and fire clays, which have been discovered.

At one locality on Mine creek, a good show of galena was observed in the sandstones and shales of the Marais des Cygnes coal series.

LOWER CARBONIFEROUS.

The rocks of this formation consist of chert, and cherty conglomerate at the top, and coarse gray limestones and hornstones below. They first come to the surface in a branch north of Baxter's Springs, and were next seen at Baxter's Springs and down the branch to Spring river. A thickness of 120 feet was exposed at these places.

This is the lead-bearing limestone of Southwest Missouri. The extensive and rich veins at Granby, Center creek and Turkey creek, east of the State line, are in these rocks, and these deposits and veins of lead may be expected in Kansas as well as Missouri.

When in Southeastern Kansas the season was so late we had no time to examine these strata for lead.

These are the lowest and oldest rocks in the State. They occupy the surface over a small area, only in the southeast, and then dip beneath the coal measures in their extension, to the north and west.

ECONOMICAL GEOLOGY.

The Geological Survey has been too limited in the range of its investigations to yield the best possible results for economical and practical purposes; yet enough has been done to enable us to state many very important economical deductions.*

SOILS.

Nothing has a greater influence over the character and power of a nation, and over the wealth and happiness of individuals, than the soil and the cultivation bestowed upon it by a people. It should therefore receive the fostering care of the State; and, besides, there is no department of human industry whose profits have been more advanced by science, than those of agriculture, and none upon which the future prosperity of our State so much depends.

Soils are a well-known mixture of various decomposed mineral substances, combined and mingled with decayed vegetable and animal remains, all comprising those ingredients peculiarly adapted to the nourishment of the vegetable kingdom. They are formed by the action of water, (particularly in the form of rain and dews,) cold, heat, and other atmospheric influences, together with the co-operation of the vegetable and animal kingdoms. If a rock, fresh from the quarry, be exposed, its surface will soon present a dull, earthy appearance, which is caused by a disintegration of its surface by atmospheric influences. Fine particles have been sepa-

* The investigations of the Missouri Survey have aided us very much in the Economical department of this Report, as it has also in the classification and arrangement of the Formations.

rated from the mass, and this meager coating of decomposing mineral matter will soon become the resting place of numerous microscopic germs, which will be developed into a minute growth of lichens. These, in turn, will decay, and add their remains to the pulverized particles, and prepare them to sustain a more vigorous growth of herbs, and to become the abode of the small insects and worms which will burrow in their recesses, feed upon the increasing vegetation, and swell the mass, both by their mechanical agency, and by adding their exuviæ to the accumulating soil. Larger plants and animals will accelerate the process by their more powerful agencies, and by the greater amount contributed by their decaying remains. Thus, by almost imperceptible increments, our rich, deep soils have been accumulated.

A clear and full understanding of the relations sustained by the soil to the vegetable kingdom or to the crops, will enable us to understand more fully what properties are beneficial and what injurious; what should be added where the soils are defective, and what neutralized when redundant. These relations may be briefly stated as follows:

1st. It serves as a foundation for, and gives mechanical support to, the plant.

2d. It supplies the plant with the inorganic and a part of the organic elements which its nature demands.

3d. It absorbs heat, air and moisture, which are essential to healthy vegetation.

4th. It is the laboratory in which the food of the vegetable is prepared to be taken up by its roots.

The best classification of soils yet proposed, is based upon the proportion of *Silica*, *Alumina* and *Lime*, the three earths which enter more largely than any others into the composition of soils. When *Silica*, or *Sand*, is most abundant, the soil is called *Siliceous* or *Sandy;* when the *Alumina*, or *Clay*, prevails, the soil is *Argillaceous*, or *Clayey;* but when *Lime* abounds, it is *Calcareous*, or *Limy.* The *argillaceous* soils may contain an unusual quantity of *silica*, when it would be called a *silico-argillaceous* soil, or a *somewhat sandy clayey soil.* The same principles govern the varieties of the other classes.

But a large portion of the soils of Kansas are composed of these three earths in such proportions that it is difficult to say which prevails, or to which class they properly belong. This is the case with nearly all of those founded upon the Bluff Formation.

The manner in which soils are formed, as described above, proves that their properties must, to a great extent, depend upon the rocks from which they are formed. If, for example, the surface rock be a clay, the soil will be clayey, or argillaceous, heavy and cold; if it be limestone, it will be limy, or calcareous; and if it be a siliceous marl, the soil will be sandy, clayey and limy, the best composition to make a light, warm, productive soil. If such a soil as the last have an abundance of decayed animal and vegetable matter, and depth enough, it will be all that could be desired. And this last is precisely what we have in a large portion of Kansas.

The various formations, however, as described above, give the soils formed from them peculiarities of structure and composition.

The *Bluff*, when fully developed, is a fine sandy marl of the following chemical composition:

Silica,*	77.02
Alumina and peroxide of iron,	11.05
Lime,	3.25
Potassa,	1.05
Magnesia,	1.63
Soda,	A trace.
Carbonic Acid,	2.83
Water,	2.48
Loss,	74
	100.00

This composition gives precisely the ingredients most desired to form the basis of a soil and its subsoil; as the soils formed by mixing with them a sufficient quantity of organic matter, will be strong, light, warm, (or, in common parlance, a "kindly rich soil,") in the highest degree productive. The organic matter will supply the phosphorus, ammonia, sulphur and humus needed for the sustenance of the crops. The

* Dr. Litton's analysis for the Missouri Survey—unpublished notes.

clay, magnesia, lime and humus will give the soil great power to absorb moisture, and the humus and magnesia great capacity for retaining it.

In the Bluff Formation, therefore, when well developed, we have all the ingredients desirable in a rock from which to form a soil and subsoil. All that need be added is a sufficient quantity of decayed organic matter; and this the decaying plants and animals of a long series of ages have abundantly supplied, and thus formed one of the best soils on this continent; as shown by the following analysis of a soil from a high, cultivated ridge, underlaid by well-developed Bluff:

"Soil No. 1, A.," 8 inches below the surface, and "No. 1, B.," 18 inches below the surface. Of 100 parts, dried at 100° C., it contains:

	Soil No. 1, A.	Soil No. 1, B.
Organic matter and water,	5.6470	4.2936
Insoluble in acid, silica, etc.,	88.1600	84.2900
Chlorine,	0.0075	0.0050
Sulphuric Acid,	0.0090	0.0300
Silica,	0.3131	0.2940
Peroxide of Iron,	2.5135	4.6680
Alumina,	2.5309	4.5968
Lime,	0.6205	0.5153
Magnesia,	0.5262	0.7875
Alkalies as Chlorides,	0.6670	0.6705
Phosphoric Acid,	1.1985	0.1817

This soil had been cultivated several years in hemp, corn, wheat and tobacco; but no dressing of any kind had ever been applied to it. The crops raised from it were as good as an ambitious farmer could wish. Here, then, we have an example of a soil formed upon the siliceous marls of the Bluff Formation, which both analysis and a succession of luxuriant crops have proved most productive and durable. The analysis of the subsoil "No. 1, B," also shows it to possess all the ingredients needed to restore the soil when exhausted by a long succession of crops. And, when desirable, the subsoil plough will raise them to the surface and restore the soil to its primitive fertility. When explaining the characteristics and range of the Bluff, it was shown that it underlies the soils in nearly all the high lands of Eastern Kansas; and wherever this formation presents its usual characteristics, the soils are similar to the one just described; and will be found most pro-

ductive and durable. Such is the character of a large portion of the soils in all the eastern tier of counties, from Doniphan to Bourbon, and Jefferson, Jackson, Shawnee, Douglas, Franklin, Anderson and Osage, and portions of Coffey, Lyon, Wabaunsee, Davis, Potawatomie, Brown, Nemaha, Riley, Greenwood and Butler, and some small areas in other counties.

In many places, particularly on the high ridges, the rains of the many past ages have washed away the finer and darker materials of the soil, and left it thin, and sandy, and light colored. In all cases of this kind, the subsoil will be found to possess more of the fertilizing elements than the surface, and deep plowing and subsoiling will greatly improve its energies.

When the Bluff is but sparingly developed, it is more clayey or sandy, and is more or less colored by the underlying rocks, and usually produces a soil of a quality somewhat inferior, though still rich and productive. In parts of Cherokee and Neosho, and some other counties, the underlying shales have rendered the subsoil too clayey and retentive, on the ridges and slopes. In like manner the sandstones have rendered the subsoil light and porous, and the soil too sandy; as seen in the Black Jack region, about St. George. And the same effects may be observed on all the high ridges capped by the Triassic? and cretaceous sandstones between the Blue and the Republican, the Solomon and the Saline, the Smoky Hill and the Cottonwood, and to the southwest.

But the rocks underlying the Bluff are not always deleterious in their effects upon this formation and the soil over it. For, throughout the whole belt of country occupied by the gypsum-bearing marls of the Permian and Triassic? Systems, the soils of the valleys and slopes, and even many of the highest ridges, are wonderfully productive.

These effects are most obvious in the valleys and on the slopes of the Cottonwood and its tributaries, on the Smoky Hill, and on Gypsum, Holland and Turkey creeks, and the headwaters of the Blue.

In all this region the prairie grasses are very luxuriant, and often grow very thick and to the height of eight and ten feet.*

* The Indian grass (*Sorghum nutans,*) and the Beard grass (*Andropogon furcatus,*)

The grasses on these rich slopes and valleys will make from three to ten tons of hay per acre. The hay made from them is highly esteemed, and commands as high a price as timothy. The crops upon this variety of soil are also very luxuriant.

The *Bottom Prairie* and *Alluvium* of our river bottoms generally produces a light, rich, siliceous soil, which often sustains a larger growth of timber than any other in the State. This growth is cottonwood, sycamore, white and sugar maple, box-elder, slippery and American elm, red birch, black, white and blue ash, coffee tree, wild cherry, buckeye, honey locust, burr, white, swamp white, rock-chestnut, laurel, pin, red and scarlet oaks, common, shell-bark, thick shell-bark and pignut hickories, hackberry, pawpaw, red-bud, black and white walnuts, linden, wild plum, several willows, pecan, mulberry and red birch. The trumpet creeper, poison ivy, and several species of grape, almost cover with their graceful foliage many of the largest trees.

This variety of soil occupies the bottoms of all our large streams, covering an area of millions of acres. It is not surpassed in fertility by any in the State, and is particularly adapted to corn, and hemp, and wheat. It is usually so light, and porous, and deep, that in wet weather the superabundance of water readily passes off; while in drought, the roots sink deep, and the water below easily ascends by capillary attraction, and keeps the surface moist. These scientific deductions are abundantly sustained by the experience of the unprecedented drought of 1860; as the corn fields on this soil suffered comparatively little injury from it.

The broad rich bottoms of the Missouri and the Kansas, the Republican and the Smoky Hill, the Saline, the Cottonwood and the Verdigris, the Marmaton and the Neosho, the Marais des Cygnes, the Stranger, the Grasshopper, the Blue and the Arkansas, all furnish good examples of varieties founded upon the sands, marls, clays and humus of the Bottom Prairie and the Alluvium.

The Drift, when it lies near the surface, fills the soil with sand, pebbles and boulders. The brown flint pebbles so often seen in the soil in some localities, and the boulders which

are very abundant and luxuriant in this soil.

sometimes appear on the ridges, are from the Drift. These materials very much injure the soil; but, fortunately, they occupy only a very small area in the entire State.

The *Coal Measures* produce a variety of effects upon the soil, according to the character of the rocks which come to the surface. The soft micaceous sandstones render the soil arenaceous; as at St. George, and a few localities in Osage and Anderson; while the shales and clays form a very argillaceous, cold and wet soil. But the deleterious effects usually produced by the Coal Measures, are prevented by the thick Bluff deposit, which covers nearly all the coal strata in the State; and, indeed, the very best soils of the State overlie the Coal Measures.

Such are the principal varieties of soils in Kansas; and no State or country can boast of soils better adapted to the usual products of the farm. The luxuriant growth of wild grasses, and the timber, and especially the crops, all confirm this judgment, all speak in eloquent praise of the Kansas soils. Though lying adjacent, on the east, to one of the fairest and richest agricultural regions of the continent, Eastern Kansas suffers nothing in the comparison, as a most beautiful and productive country.

A State with such a heritage, capable of sustaining and feeding millions, should use every means within the power of government and people to preserve and transmit it, not only unimpaired, but rather improved, to successive generations. He who exhausts his soil by bad tillage, deprives the State of its greatest element of power, and his children of their birthright.

COAL.

As has been shown, the coal-bearing rocks are 2,000 feet thick, and underlie an area of over 17,000 square miles in our State. In these rocks there are 22 distinct and separate beds of coal. Many of these are thin, and of but little practical value; but ten of them, range in thickness from 1 to 7 feet of coal suitable for domestic and manufacturing purposes.

The upper beds are thin and not persistent or continuous;

in other words, they are not always present in the rocks which usually contain them. But the lower beds are thicker and more persistent. The rocks which contain these upper coal beds crop out in the northern and western portions of the area occupied by the Coal Measures; and this fact explains the scarcity of workable coal beds north of the Kansas, and west of Shawnee, on the south of that river. But in the southeast, where the lower Coal Measures crop out, the coal beds are abundant in nearly every county.

The beds which are 1 foot and over, furnish an average thickness of over 25 feet; and, although some of these beds are not persistent, and some do not occupy the whole region, yet there is scarcely a doubt that these beds would furnish enough to cover the entire 17,000 square miles with 12 or 15 feet of good coal. If we suppose that only one bed, the thickest which will average 6 feet, underlies the whole coal field, it alone will yield* 6,000,000 tons for each square mile, and for the 17,000 square miles, known to be occupied by the coal-bearing strata, 102,000,000,000 tons, enough to supply all possible demands for generations to come. And, besides, should the coal in this area be exhausted, it will be remembered that these Coal Measures extend westward beneath the Permian Rocks to an unknown extent; but probably throughout the entire central and western portions of the State, some, at least, of the coal beds also extend under those regions; and there will be no more difficulty in raising this coal than has been overcome in many of the most productive mines in England and other parts of Europe.

Coal beds crop out in Brown, Atchison, Doniphan, Leavenworth, Miami, Linn, Bourbon, Cherokee, Neosho, Allen, Woodson, Greenwood, Coffey, Franklin, Osage, Douglas, Shawnee, Wabaunsee, Jackson, Nemaha, and perhaps other counties.

The quality of a large part of the Kansas coals, is good. Some of the most important beds are very free from sulphur and other impurities. They cake and coke well, and will be valuable for gas manufacturing purposes.

* Mining engineers allow 1,000,000 tons per square mile for every foot in thickness of bituminous coal.

The position of these various coal beds, and the best means of determining their position and depth, when under the surface, and of mining them, will be given in the final report.

BROWN COAL OR LIGNITE.

It has not been our privilege to examine the western and central portions of the State, where the beds of lignite are found; but enough is known from undoubted authority to establish the existence of thick beds of good brown coal, over a large area in Western Kansas. These beds crop out on the Smoky Hill, from Cedar Bluffs (some 25 or 30 miles from Salina,) westward. In thickness they range from 3 to 7 feet. Our information is too limited to give any definite idea of the extent of country underlaid by them; but we know they extend a long way up the Smoky Hill, and probably beyond the western boundary of the State.

The importance of these vast beds of fuel along the valley of the Smoky Hill can scarcely be estimated. Without them, this beautiful and fertile valley, destined to be the great line of travel to the Mountain States, would be but sparsely populated. But with this abundant source of fuel, towns and villages will rapidly spring up, surrounded by flourishing communities, whose surplus products will supply the mining population in the Mountain States.

GYPSUM.

We have proved the existence of vast beds of gypsum, cropping out across the central portions of the State, and extending westward beneath the cretaceous and tertiary rocks. A large part of these beds are the pure white granular sulphate of lime, most valuable in the arts. It is very much used in forming fine plaster and stucco work, for plaster casts, and for cements, now extensively used in manufactures. But its well known effects upon poor, and even barren, sandy soils, give to this deposit a transcendent importance in Central and Western Kansas.

These "plaster" beds will enable the farmer, at small cost, to render the poor sandy ridges and plains in Western Kan-

sas as fertile as the ridges and valleys which have the *wash* from these beds. (See p. 8.)

The quantity of gypsum in these beds is so great that they will easily supply the demand of the Mississippi Valley for many generations.

IRON ORE.

The shales of the coal measures contain numerous bands of *Kidney Ore*, or *Spathic Iron*, of good quality. It often occurs in bands of detached septaria, as in the Pawnee Limestone Series. Large quantities of good ore were found on the Marais des Cygnes, below the Trading Post, in the neighborhood of Fort Scott, on the Neosho above the State line, and at many other localities. These deposits of iron ore are interstratified with beds of good coal, and will, at no distant day, become valuable for the manufacture of iron.

There are extensive iron beds in the sandstones of the Cretaceous? System in Central Kansas; but the sand, mingled with the oxide of iron, will render the most of it useless for manufacturing purposes.

The Tertiary strata, in the western part of the State, probably contain extensive beds of this ore.

LEAD.

At Potosi, on Mine creek, in Linn county, galena has been found in small quantities in No. 190 of the foregoing section. The lead is found in small crystals in the mass of the shales, or in thin sheets between the laminæ of the shales and sandstones. Considerable mining had been done here at some time prior to the occupation of the country by the present population. There are evidences that the strata have been disturbed, tilted and fractured at this and various other localities between Potosi and Fort Scott.

The sandstones and shales have a strong dip to the southeast. They probably form an anticlinal axis on the ridge to the west of the mine, where lead has also been found in the soil. Whether these mines will prove productive, it is impossible to determine in the present stage of the work.

FIRE CLAY.

There are numerous argillaceous beds in the coal measures which present all the physical properties of good fire clays. There is a thick bed under the coal at Fort Scott, and one under the black slate in the ridges above Lawrence, which extends thence to Leavenworth, and northward; and one under the coal west of Topeka, and in the branch east of Lecompton, and another on Mill creek, and others in various parts of the State, which appear like good fire clays, but chemical analysis or actual experiment alone, can fully determine whether these beds will yield fire brick of the best quality.

MARBLE.

A bed of fine black marble, full of yellowish veins, was discovered at Moor's branch, and on the Marmaton, near Fort Scott. Some portions of this marble will receive a good polish and make beautiful slabs for various ornamental purposes. In connection with some light-colored variety, it would form a beautiful and durable tessellated pavement for halls, courts and public rooms.

Some parts show a disposition to crack into angular fragments when long exposed, but good sound blocks and slabs may be obtained by stripping off the surface materials, or by quarrying it beyond the action of the weather. Unless care be taken to obtain sound blocks, it will be more or less liable to crack by long exposure to atmospheric agencies.

BUILDING MATERIALS.

Clays.—Some portions of the Bluff Formation make good bricks, as may be observed in the brick yards at Leavenworth, Atchison, Wyandotte, Lawrence, Topeka, and many other towns where bricks are manufactured from the marly clays of this deposit.

These beds exist under the soil in nearly every township and section in the eastern portion of the State.

Sand suitable for bricks, mortars and cements exists in the

lower part of the bluff; as in the brick yard below the bridg at Lawrence, in the altered drift, and in the sand beds of th alluvium of all the river bottoms. Beds of good sand ar also found in the Cretaceous? and Triassic? rocks in the cen tral portions of the State.

Sandstones of various colors and degrees of hardness, suit able for building purposes, underlie the whole of Kansas, and crop out in very many localities. There are quarries o a beautiful buff variety a few miles east of Fort Scott, and also northwest of that town, from which good stone is often obtained for building purposes.

In the bluffs of the South Fork of the Potawatomie, south east of Garnett, and also a few miles southwest of Ottawa, are fine, regular strata of the same variety of sandstone. Rock from the last locality, is used in the college building at Ottawa.

There is also a higher bed of red sandstone at this last locality, which is harder, stronger and more durable. A building with the foundations, door-posts, window-sills, caps and cornices of the upper red beds, and the other portions of the buff beds, would be very elegant and tasteful.

Limestones of numerous varieties are found in large quantities. Some one of the hundred different beds, crops out in nearly every ravine, and bluff and hillside. The regular beds of drab and buff magnesian limestones of the Permian System, are both durable and beautiful, as may be seen in the numerous buildings at Fort Riley, Junction City, and in numerous farm houses and fences throughout Central Kansas.

Some one or more of the twenty magnesian limestones of this system, crops out in nearly every valley and hillside on the Blue and its tributaries, the lower part of the Republican, and on the Kansas from Mill creek to Solomon's Fork, on the Cottonwood and tributaries, and on the head waters of the Marais des Cygnes, the Neosho, the Verdigris and Fall river.

The limestones of the coal measures crop out along the ridges in all the country east of the region occupied by the magnesian limestone, as described above; and some one of

ıese beds furnish good building stone in nearly every town-hip.

Limestones suitable for *quick-lime* and *hydraulic cements* re also abundant.

The limestones and sandstones described above, furnish an mple supply of good material for the best of all stone fences.

SALT.

There are large quantities of brine in the salt marshes on he southern boundary of the State, west of the Arkansas, ɔn the Saline, and elsewhere. There are also bold brine ɪprings at the above localities, on the Smoky Hill and the Republican, and on Solomon's Fork and the Verdigris, and ɪt Hamilton, in Brown county.

Large quantities of good salt are annually formed at some of the salt marshes by solar evaporation.*

Salt works have been established at Osawatomie which have produced an excellent article from brine obtained by boring. The favorable location of these brines for solar evaporation will render them sources of great wealth.

PETROLEUM

In some one of its various forms saturates the sandstones and fills the crevices of the rocks, and flows to the surface through their fractures in numerous localities. It was observed in large quantities in Miami county† and in several places in Linn, Bourbon, Cherokee, Douglas and Shawnee. The indications are most promising at several of these localities, especially the southeastern, as will be shown in the final report.

PAINTS.

There are several beds of purple shales in the coal measures, which appear to have all the properties of a good out-

* See the Journal of "The Southern Boundary Survey" for July 20th.

† See Report of Miami county.

years, and the meteorological observations, prove that Kansas has been as free from droughts for the last thirty-five years as any other of the Western States.*

The statement of the Indians and Missourians all agree, and are conclusive on the subject, as shown by the following note from the *Head Chief* of the Kaskaskia, Peoria, Piankeshaw and Wea, confederate tribes, which is a fair sample of the testimony collected from the old Indian farmers:

PAOLA, MIAMI COUNTY, KANSAS, Oct. 30th, 1865.

Prof. G. C. Swallow—Sir: I have cultivated my farm, in this county, for thirty-five years, and have raised good crops every year but one, A. D. 1860, and have had no serious injury from droughts previous to that year. The experience of other farmers in my tribes is the same as mine in respect to crops and droughts.

(Signed) BAPTISTE PEORIA.

We thus have the testimony of those who have lived here and cultivated farms, and the records kept at the military posts, both showing that there had been no lack of rain in Kansas for at least thirty years previous to 1860; and that the drought of that year, and partial one in 1864, are only such exceptions to the general rule, as occur in all countries.

STAPLE CROPS.

Corn, wheat, rye, oats, barley, buckwheat, sorghum, Hungarian grass, potatoes, and all varieties of garden vegetables, grow with great luxuriance, and ripen large crops. Hemp and flax also succeed well; cotton produces small crops, and tobacco grows with great luxuriance, and produces good crops when protected from the violent prairie winds.†

FRUIT.

As indicated by the abundance and perfection of the wild varieties, the fruits of the Temperate Zone do well in this State. Wild plums, cherries, crab-apples, grapes, and strawberries, blackberries, raspberries, gooseberries, pawpaws, and

* For the details of the evidence, see Dr. Sinks' Report.

† In some prairie regions, tobacco is planted in alternate rows with corn, to protect it from the wind, which injures its leaves.

haws grow with great luxuriance and produce excellent natural fruits. The improved varieties of apples, pears, peaches, cherries, plums and grapes, usually grown in the West, do well, and there is no doubt that the small fruits will also succeed admirably when aided by the improved methods of culture usually adopted in the West to protect them from the drying heat of our warm summers.

The warm, dry atmosphere, and loose, warm, calcareous soil, gives the State a peculiar adaptation to the culture of the grape. The wild grapes come to great perfection, and there is no reason why the hardy varieties commonly cultivated in the West, should not do well.

STOCK RAISING.

The great luxuriance and excellence of the native grasses, the abundance of water, and the short, mild winters, will enable this State to compete with the most favored regions of the continent in this department of husbandry. Many of the grasses and vines remain green all winter in the timbered bottoms, where animals do well through the winter without extra food or artificial shelter.

Sheep succeed extremely well, and yield large profits. The horses and mules, herds and flocks, are in no respect inferior in quality to those of the older States.

FENCES.

If the State could adopt such laws and regulations as would enable the rural districts to dispense with fences, a vast outlay of capital and labor might be diverted to more productive improvements. Under the present system, at least one-half of the expense of improving a farm is incurred for fences to protect the crops. If this could be devoted to improved modes of culture, or to increase the area of improved lands, the amount of agricultural products would be nearly doubled.

As, however, the present system will doubtless be continued, the best means of securing good, permanent fences

should be adopted. Though good lumber for wooden fences is abundant in nearly all the eastern counties, still, the want of durability in wooden fences makes it very desirable to adopt something more permanent, and the scarcity of lumber in some localities renders this course absolutely necessary.

Three kinds of fences have been proposed and partially adopted:

1st. *Wire fences*, when well made, do well, but the high prices demanded at present are a serious objection.

2d. *Stone fences* have been extensively adopted in many countries. They give good satisfaction and will doubtless be more generally built, as a large portion of the farms in Eastern and Central Kansas will have rock enough for this use.

3d. *Osage Orange Hedges* have been set in many places, and, when properly managed, have succeeded well. In the rich soils of this State, good cultivation and judicious management will secure a first class, living fence in four years.

RAILROADS.

But little has been said of the intimate relations between the railroads and geology of a country. The cost and durability of the road-bed depend as much upon the geology of the country as upon the topography, on what is under the surface as upon the character of the surface itself. The engineer must know the geology of his route well to decide intelligently between "cuts and fills," or "curve and tunnel," and to determine with certainty the ability of a stratum to sustain the abutments and piers of culverts and bridges.

The stockholders also need a full knowledge of a country to determine whether it can sustain the population and furnish the freight necessary to make the investment profitable.

A few only, of the facts important to the proposed railroads of the State can be stated at this time.

The Union Pacific is doubtless the most important of the proposed roads, as it traverses the entire length of the State through its central and richest portions, and will transport its people and their merchandise, and the populations and their merchandise of the Mississippi Valley and of the Atlantic

States, the Mountain States, and the Pacific States, and even the people and merchandise of Europe and the Indies will pass over it.

Though these facts fully prove that the investment will be a good one, still it may encourage and hasten the good work to know that its route to Fort Riley is up a valley unsurpassed in its adaptations to the necessities of construction, the fertility of its soils, the abundance and purity of its waters, and the quantity and quality of its timbers. And, besides, the whole valley is underlaid and skirted by beds of good bituminous coal. Should this road continue up the Kansas and Smoky Hill, the most direct and every way desirable route, it will still pass through a rich, well watered, agricultural region, so level that scarcely a cut or fill will be needed, and but few small bridges and culverts.

The diminished quantity of timber will be more than made good by the vast beds of brown coal, which crop out along the line.

The inexhaustible beds of pure gypsum directly on the route, would furnish freight till the markets of the Mississippi Valley are all supplied.

The route up the Republican is longer, more expensive, and through a country far inferior in fertility of soil, and nearly destitute of timber and coal, and some portions without any permanent supplies of water.

The Kansas City and Fort Scott Railroad, leading from Kansas City through the rich counties, Johnson, Miami, Linn and Bourbon, to Fort Scott, and thence southward to Fort Smith, runs through one of the richest, most beautiful and delightful countries on the continent. It has a soil as rich as Egypt, a climate as delightful as Italy, and streams as beautiful as they are numerous. This entire region, from the Missouri to the Arkansas, is underlaid with vast beds of coal and iron. It has natural resources enough, and can sustain a population large enough to support twenty such roads. It is fast filling up with a brave and earnest people.

The Leavenworth, Lawrence and Fort Gibson Railroad, from Leavenworth to Lawrence, and south through the second tier of counties to the valley of the Neosho, and thence

to Fort Gibson, traverses a country similar in all its main features to that just described along the Kansas City and Fort Scott Railroad.

The *Western Branch*, from Lawrence up the valley of the Wakarusa, and across the head waters of the Marais des Cygnes to Emporia, in the valley of the Neosho and Cottonwood, will pass through as rich and beautiful an agricultural region as heart could wish. Several coal beds crop out along the route.

The Atchison, Topeka and Santa Fe Railroad, from Atchison, through Jefferson county, to Topeka, and thence southwesterly to and up the valley of the Arkansas, will pass through a country distinguished for its fertility and rapid development. Coal beds come to the surface in several counties along the line.

The Atchison and Pike's Peak Railroad, from Atchison westward, through Northern Kansas, will intersect a country of great agricultural resources, over the coal measures of Eastern Kansas, and the gypsum-bearing rocks on the Blue and the Republican, and their tributaries.

The railroad from Doniphan, westward through the northern tier of counties, will pass through a country similar to that intersected by the Atchison and Pike's Peak road.

The Missouri River Railroad, already far advanced towards completion, along the bluffs of the Missouri from Leavenworth to Wyandotte, derives its chief importance as a connecting link in the great line of travel and trade between the largest city on the Missouri and the commercial emporium of the Mississippi Valley.

The Southern Branch of the Union Pacific, from Fort Riley down the valley of the Neosho, and the road from Pleasant Hill, in Missouri, to Lawrence, will pass through regions already described as rich in coal and agricultural resources.

In short, all the railroads in the projected Kansas system, will pass through regions of such varied natural resources as will render them, when once completed, great thoroughfares of travel and trade.

Such, in brief, are some of the natural advantages which

have enabled this State to advance so rapidly in population and wealth. Scarcely ten years have elapsed since the General Government opened this rich and beautiful portion of the public domain to the indomitable and thrifty people of the Republic. Cities and towns have sprung up like magic, each surrounded by flourishing agricultural communities. All have brought with them the characteristic and favored institutions of the land. Churches are everywhere fostered and sustained. Schools of every grade are munificently endowed, and are rapidly approaching the completeness and efficiency of the best seats of learning in the older States.

GEOLOGICAL REPORT OF MIAMI COUNTY.

Miami county covers an area of 600 square miles, in latitude 38 degrees 30 minutes, and longitude 95 degrees west, and near the center of the eastern boundary of Kansas. Its surface is a high rolling prairie, intersected by numerous streams and broad valleys. The high prairie ridges wind and curve in every imaginable form, and sweep by gentle slopes down into the broad winding valleys, which are intersected by numerous timber-skirted streams, and dotted here and there by picturesque mound-like hills. Such are the general features which render this country beautiful in the extreme.

When we descend into an examination of rocks, soils, streams, springs, forest and prairie, we shall find the utility of the minuter details as striking as the general outline.

GEOLOGICAL HISTORY.

The limestones of this region were formed in the ocean, as is fully proved by the animal remains found in them; for these animals are such as lived in the ocean and nowhere else. When, by geological changes, the country was raised above the water, its surface was nearly level and somewhat higher than the tops of the present hills and ridges.

In the process of time, the valleys and ravines were worn out by the action of the surface waters and streams, leaving the present ridges and mound-like hills and ravines, with their sides and slopes somewhat more abrupt than they are at the present time.

It was during this period that the beds of gray and brown clay and fragments of rock, mostly flint, which rest upon the

consolidated rocks of the coal measures, were formed from the harder materials of the rocks, worn and swept away by the waters of that period.

We know but little of the history of this period of denudation, save that the waters must have been abundant and the streams powerful, to have worn such deep, broad valleys, and borne away the materials. If any animals and plants lived here during this period, their remains have been swept away and destroyed, as no evidence of their existence has been found. Subsequently, this whole region, Eastern Kansas and Nebraska, Iowa, Illinois, Indiana, Ohio, Missouri, and parts of Kentucky, was covered by a vast fresh water lake.

In this lake was formed or deposited the beds of gray and brown marl, which underlies and forms the basis of the rich soils in all this vast region. Shell-fish, such as occupy our present waters, lived in this lake. Forests of elm, sycamore, walnut, oak, and other trees like those of our present forests, grew upon the shores of this lake. The squirrel, beaver, deer, elk, buffalo, elephant and mastodon lived in the forest upon its borders.

The history of these times is found in the petrified wood and shells and bones of the trees and animals of these days, carefully laid away in the marl beds or bluff formation deposited in this lake, and which are from time to time brought to light by examinations of these beds and their contents.

The remains brought to light by the examinations in Pompeii, Herculaneum and Ninevah, do not tell the history of those cities more accurately than the petrified trees and shells and bones exhumed from the marls of the bluff formation tell the history of this lake and its shores.

By some changes of the succeeding ages, the lake was drained away, exposing the surface of the earth somewhat changed. The marls deposited in the lake had for the most part covered up the limestones, and sandstones and shales, partially filled the deepest valleys, rendered the slopes more gentle and smoothed up the rugged and precipitous hillsides, presenting a contour of surfaces of valley and hill substantially as it has remained to the present time.

The streams, it is true, have cut their channels into the

surface marls, and in some instances into the solid rocks below, and the waters have cut ravines and carried away some of the surface materials, but the contour of the surface remains substantially as it was left by the waters of the lake. As a matter of course, a rank growth of weeds, grass and trees sprung up on the rich marls left by the receding waters.

Then was the broad area, once occupied by the lake, one unbroken prairie. Fires swept over the surface and killed out the young trees and such other plants as could not endure the annual burns.

Thus it is seen that prairie is the normal state, and the question should be how the forests were formed? and not what made the prairies? But there were ravines and wet places which fire did not reach, and there the trees grew apace and produced the present forests. Meanwhile, the fish and reptiles occupied the present streams and lakes, and the animals became the dwellers of the forests and prairies. Animals and plants died and decomposed, and formed a black matter which mingled with the surface marls and formed the soil, the best and most valuable of the geological formations. The soil by this process is formed exceedingly slow, but the increase is as sure as it is that animals and plants will die and decay, and the waters fall and run, and the winds blow, and the animals walk and burrow and dig, and thus mingle the decaying matter and the loose surface deposits. Slow as the process, the long period since that lake was drained away has been ample for the formation of the deposit and richest soil of the continent. The record, distinct and definite, has been impressed upon the rocks, where it must remain as imperishable as the foundations of the earth itself. There is a great variety of details in this record, which we have no time or space to relate. It might be interesting to consider the vast number of fishes that lived in the carboniferous seas, their names and varied habits, how the waters ebbed and flowed and ripple-marked the sandy shores; what tropical suns poured down upon dense, steaming forests of palm and fern, and how rank vegetation sunk beneath the waters and formed the coal beds for man's use; but the utilitarian relations of these rocks claim our present attention.

SECTION OF THE ROCKS IN MIAMI COUNTY.

SURFACE DEPOSITS.

No. 1.—1 to 6 feet *Soil.* The soil in this county is usually a rich calcareous loam, made up by mixing decayed organic matter with the marls of the Bluff Formation below.

No. 2.—1 to 20 feet *Bluff.* This is the fine buff and gray siliceous marl which is commonly known as "surface clays." This formation was deposited in a fresh-water lake, which once covered a large portion of the Mississippi valley, and is the basis of nearly all the soils of this rich agricultural region.

No. 3.—2 feet *Drift.* There is found in many places in the county, between the Bluff and the underlying carboniferous rocks, an irregular bed of gray, sandy clay and water-worn fragments, mostly flint, of the underlying rocks. This formation sometimes comes so near the surface that the flint pebbles mingle with the soil, as seen near Miami and other localities.

COAL MEASURES.

No. 4.—2 feet *Black Slate*, or *Bituminous Shale.* This rock was exposed in Mr. B. H. Stile's well, south of Spring Hill. It was not seen in any other locality.

No. 5.—9 feet *Buff Limestone.* This rock was passed through in Mr. Stile's well, south of Spring Hill. The only locality in which it was seen.

No. 6.—9 feet *Shale* and *Sandstone.* This is a dark blueish-gray, hard sandstone, with grayish-blue shales. It was also exposed in Mr. Stile's well, south of Spring Hill. It was seen nowhere else.

No. 7.—25 feet *Stanton Limestone.* The upper portions are usually thick beds of soft, light-gray, magnesian limestone, full of brown, ferruginous spots, having, when exposed, small water-worn holes in the fragments. This part is more or less filled with plates and spines of *Echinoderms*, some *Fusulinas*, and *Productus*

Americanus, still more rare. The beds below are regular, of medium thickness, harder, and often very full of a variety of *Athyris subtilita*. The beds still lower are blueish-gray, weather-brown, and separate into angular fragments by plane or conchoidal fractures. This limestone is well exposed in the eastern bluffs of the Marais des Cygnes, in the highest points north of the "Devil's Backbone," above Stanton. It also appears at Coldwater Grove, and in all the highest ridges between those points, and in numerous places in the north part of the county, as Cavé Springs and Buzzards' Roost. The cave at Cave Springs, south of Spring Hill, and the Sink Holes, near Wea Cave, and at Coldwater Grove and other places, descend into this rock, the upper portions of which are so soft and porous that the water has worn out the holes and cavities so characteristic of this formation.

No. 8.—15 to 28 feet *Sandstone*. This is usually a hard, gray, calcareous sand rock, in thin beds, passing into shales and fire clays at top and bottom; but, in places, it is a brown, soft, micaceous sandstone.

No. 9.—20 to 30 feet *Cave Limestone*. This rock is usually a hard, brown, brittle limestone, in beds of medium thickness, and separated into fragments by numerous vertical fractures. Some of the beds are gray and drab, with brown specks and blue concretionary nodules disseminated through the mass. It usually has brown cherty beds at the top, and irregular masses in and between the beds below. It contains *Spirifer cameratus*, *hemiplicata*, and *lineatus*; *Productus costatus*, *Flemingi*, *Rogersi*, *punctatus*, *cora*, *semireticulatus* and *equicostatus*; *Athyris subtilita* and *Terebratula millepunctata*; *Euomphalus rugosus*, *Crinoids*, *Chaetetes*, *Gorgonias*, *Zaphrentis* and *Fucoids*. When near the surface it forms deep, precipitous ravines, and steep, sharp ridges. It also contains many caves and crevices from which bold springs usually flow. This limestone forms the "Devil's Backbone," north of Stanton. It contains the Wea Cave, and is exposed above the

spring at Coldwater Grove, at McFaddin's, at Ward's Mill, and in other places in the central part of the county.

No. 10.—35 to 60 feet *Einstine Sandstone.* This is usually made up of thin beds of soft, brown, micaceous, and hard, gray, calcareous, ripple-marked sandstones, more or less intercollated with, and passing into, blue and brown, sandy, argillaceous shales. The upper part is marly and fossiliferous at McFadden's and Ward's Mill. This rock, in places, contains numerous fragments of vegetables, which are sometimes converted into coal, bituminous or char, and more rarely *asphaltum. Spirifer cameratus, Productus cora, Chonetes mesoloba*, two species *Chaetetes*, and fragments of *Crinoids* were found in the marly shales at the top of this formation. This sandstone is usually more or less impregnated with petroleum, and in many places it is so completely saturated with the oil, that it runs out and flows over the water and fills the air with its peculiar odor. The oil spring in Sec. 29, T. 17, R. 25, comes to the surface over this rock. It also appears saturated with petroleum in the southeast quarter of Sec. 11, T. 17, R. 24, and other places.

No. 11.—2 feet *Gray Limestone.* This rock is usually a hard-ringing, light-gray, fine-grained, pure limestone, filled with limpid particles and plates of calc spar. It also contains irregular masses of brown ferruginous matter. The beds are thin and very irregular. *Spirifer lineatus, Productus Flemingi, Avicula, Athyris sutilita*, and fragments of *Crinoids* were observed in this rock. This limestone usually lies on the slopes of the ridges in the middle portions of the county, in white water-worn masses. It will burn easily into a pure white lime.

No. 12.—12 to 18 feet *Sandstone.* This is usually a soft brown and gray micaceous, thin-bedded sandstone, more or less saturated with petroleum, as seen in the well of Mr. Thomas Dennis, on the farm of Dr. J. W.

Gossitt, and in the northeast quarter of Sec. 36, T. 17, R. 24.

No. 13.—3 to 5 feet *Shale.* This is generally a blue and brown sandy shale.

No. 14.—4 to 8 inches *Coal.* This coal is of medium quality and is sometimes used by the smiths, but is too thin to be worked with profit. It was observed in Sec. 31, T. 17, R. 28, and in Secs. 18 and 19, T. 18, R. 28. It also crops out in the two townships west of that last named. This coal, like most of the thin beds in the upper Coal Measures, is not permanent.

No. 15.—2 to 4 feet *Fire Clay.* This rock is usually blueish-gray and somewhat sandy. The place occupied by the last four divisions, Nos. 12, 13, 14 and 15, is sometimes filled by a blueish-brown shale or fire clay, filled with marly concretions, usually rough and elongated, as if formed from fucoidal remains; as seen at the spring west of Mr. Daniel Perry's house. At other places this space is occupied by sandstones and shales; as seen near the ford, northeast of Osawatomie. At the last locality, these beds are 24 feet thick, but at Perry's spring they are only 12 feet thick; while below Beaver Creek Oil Spring they are 32 feet. As a general rule the thickness increases in proportion as the sandstone replaces the shales, or as the arenaceous matter takes the place of the argillaceous.

No. 16.—2 to 4 feet *Spring Rock.* This is a hard, blueish-gray, fine-grained limestone, containing many fossils and crystalline particles of calc spar. When exposed it changes brown, and parts into slightly rhombic parallelograms, which finally separate into small angular fragments by plane and conchoidal fractures. It contains *Spirifer cameratus* and *lineatus*, *Productus Flemingi*, *Crinoid colums* and *plates*, and *Orthisina umbraculum*. Many of the fine springs in the county come to the surface through crevices of this rock. The large spring below the fort in Paola, the two near Mr. Perry's house, and many others might be mentioned. In fact, wherever this rock comes to the surface, we find

springs more or less permanent; as the water percolating through the rocks cannot pass the shales below, it is forced through crevices of this limestone till it finds vent wherever the rock comes to the surface. This is true, in a greater or less degree, respecting all the limestones in the county, and fully explains the fact that wells usually meet good water in passing through limestone. The oil spring in Sec. 31, T. 17, R. 25, comes up through the joints of this limestone, but its source is doubtless in the sandstone below.

No. 17.—50 to 60 feet *Sandstone* and *Shales*. This rock is usually a gray, thin-bedded, ripple-marked, calcareous sandstone, passing into argillaceous-sandy shales of blue and brown color, with beds of carbonate of iron at top and bottom, as seen at Beaver Creek Springs, but is very variable. Near the ford, northeast of Osawatomie, the upper part is blue, purple and brown argillaceous shales, with thin beds of carbonate of iron, while on the Walnut, west of Paola, the upper beds are a soft, micaceous sandstone, containing many impressions of vegetable remains. Near Rockville the lower part of this rock is sandy and oleaginous. This formation everywhere shows more or less indications of the presence of petroleum. The famous "Wea Tar Spring" comes to the surface near the top of this rock, and the Beaver Creek Tar Spring comes from the middle; and petroleum was very abundant and troublesome in several wells sunk in the lower part of this rock near Rockville. A thin bed of coal sometimes appears in the lower part of this sandstone; as seen in a branch southeast of Stanton.

No. 18.—5 to 7 feet *Blue Limestone*. This formation is made up of hard, blue, compact limestone, and flint in places, with partings of blue and drab shales. Some of the beds are blueish-gray, and some are filled with a broad-lobed *Sperifera; Spirifer lineatus* is less abundant, and *Productus Flemingi* and *Athyris subtilita* are sometimes found. At the crossing of the Wea, on the Rockville road, these rocks are 5 feet thick, without

shale partings; or, at least, the partings are very thin. These beds are found in the wells north of Rockville, and in Mr. Heimer's well, southwest of that place. A strong stream of water flows through them.

No. 19.—13 feet *Blue Shales.* This rock is fully exposed at the Wea, where the Rockville road crosses. It is made up of blue and drab argillaceous shales, commonly called soapstone.

No. 20.—15 to 20 feet *Well Rock.* The various parts of this limestone present very distinct characteristics. The upper beds are a whitish-gray, soft magnesian limestone, sometimes called "cotton rock." It is a good fire-rock, and is used for chimneys and fireplaces. The middle beds are blueish-gray and drab, hard, compact or crystalline. In places it is a hard, drab, compact, thin-bedded, argillaceous limestone, filled with hard, blue, concretionary or feucoidal masses. The lower part is usually a blueish-gray, cherty, sub-crystalline limestone, weathering brown, and parting into small angular masses. The beds are irregular, with thin shaly partings. *Spirifer cameratus, Kentuckensis* and *lineatus; Productus Flemingi, costatus* and *punctatus, Terebratula millepunctata, Athyris subtilita; Enomphalus rugosus; Chonetes mesoloba; Myalina, Crinoids* and *Nautilus nododorsata,* are found in this rock. The salt water in the wells at Osawatomie comes from this rock; but I have found no indications of salt water where the rock comes to the surface. This rock is exposed at Lykins' well, at the crossing of the Wea on the Rockville road, at the crossings of Middle creek and North Sugar, on the same road, at the ford of Bull creek west of Paola, at the fords of Marais des Cygnes and Potawatomie near Osawatomie, and on all the streams in the southern part of the county.

No. 21.—6 to 10 feet *Blue Shales.* This rock appears to be very variable in thickness. It is exposed at the Chestnut ford on the Potawatomie, below the *Well Rock.*

No. 22.—1½ feet *Blue Limestone.* This is a hard, compact, blue and blueish-gray limestone, in thin beds, with

shale partings. It is exposed on Sugar creek, northeast of Rockville, and on the military road still farther to the northeast. *Spirifer lineatus* was observed in it.

No. 23.—6 feet *Bituminous Shales.* This rock is made up of thin, hard plates of black, argillaceous matter, fully saturated with bitumen. It burns readily in the fire, leaving a large amount of gray ashes. *Discina convexa* was found in this rock. It is exposed near the Won-zop-peah Tar Spring, and other places in the southern part of the county.

No. 24.—1 to 2 feet *Blue Limestone.* This is a hard, compact, brownish-blue limestone, containing some particles and blue veins of brown calc spar. It contains *Chonetes mesoloba?* and a small *Maehrocheilus?* It receives a fine polish, and is said to contain ores of the precious metals; but all expectations founded on this report will be disappointed. It crops out near Lykins' well, and near the Won-zop-peah Spring.

No. 25.—1 foot *Blue Shales.* This bed is exposed in the ravine above Won-zop-peah Spring.

No. 26.—18 feet *Limestone.* The upper part is a hard, compact, blueish-drab limestone, filled with purple spots or concretions; the middle portion of the limestone is coarser, and filled with small, brown, ferruginous particles and cavities. The lower part is usually a hard, siliceous, sub-crystalline limestone, with numerous small, brown, ferruginous specks. Below the last is sometimes found a bed of light-drab, hard, magnesian limestone, with a three-lobed *Athyris.* In most localities the middle portion is a hard, fine, gray, sub-crystalline, cherty limestone, which weathers brown, and separates into angular fragments. It contains small white crystals of calc spar, *Productus punctatus, Rogersi, costatus, cora, semireticulatus* and *Flemingi; Spirifer lineatus* and *cameratus; Chonetes Smithi?* and numerous Crinoidal remains were found in it. This is the lowest limestone in Miami county; it crops out at the Won-zop-peah Spring, on Sugar creek near Rockville, and in all the deep ravines in the southern

part of the county. It does not come to the surface in the middle and northern part.

No. 27.—150 to 200 feet *Sandstone* and *Shales*. The upper portion of this formation is usually a dark, heavy-bedded, soft, micaceous sandstone, more or less saturated with petroleum. In places, it passes into gray, hard, thin beds of calcareous sandstone, and blueish, sandy shales, and sometimes, lower down, into beds of brown and blue sandy shales, with a few thin strata of kidney iron ore. It contains some impressions of vegetable remains. It is the lowest rock exposed in Miami county. All the deep ravines in the southern part of the county cut into this sandstone. The Wonzop-peah, the Honeywell, the Rockville, Mascoes, Godfrey, Sac Ford, and all the other oil springs and indications in the low grounds in the extreme southern part of the county, come from the upper part of this rock. The exact thickness of this formation could not be determined by any data we could obtain in this county; but from the exposure and levels on Sugar creek, in this and Linn county, it was judged to be at least 150 feet thick. Mr. W. B. Carter says his well at Osawatomie penetrated 170 feet, without reaching the bottom.

No. 28.—5 feet *Concretionary Marl*. This is a blue and brown calcareous shale, with strata of large concretionary masses of hard blue marl. This is doubtless a concretionary limestone in some places. It does not come to the surface in Miami county; but it is exposed over Kelley's coal bed in Linn.

No. 29.—13 to 33 inches *Bituminous Coal*. This coal is of medium quality, rich in gas, cokes well and burns with a clear flame. It contains some sulphuret of iron and other impurities. It is exposed on Sugar creek, about 9 miles south of the Linn county line.

No. 30.—3 feet *Fire Clay* and *Black Shales*.

No. 31.—6 feet *Limestone*. This is a hard, blueish and brown, impure argillaceous limestone in thin, irregular beds. It contains *Spirifer lineatus* and *cameratus*;

Fusilina cylindrica, Zaphrentis, and fragments of *Crinoids.*

Such are the rocks in their regular series, from the highest beds in the northern part of the county, to the lowest on Sugar creek in the southeast, giving a total thickness ranging from 315 to 350 feet. These rocks lie in a position nearly horizontal.

There are some local dips, as where the road from Paola to Olathe crosses the Ten Mile creek, in the branch north of Rockville, and at the crossing of Marais des Cygnes, northeast of Osawatomie; but these dips are merely local, and do not disturb the general level of the rocks in the county.

ECONOMICAL GEOLOGY.

SOIL.

The soil is the great source of individual and national wealth, as it is the immediate or remote source of nearly all the materials used to feed, clothe and shelter us. Its absolute value is beyond computation, as man is dependent upon it for existence. Its relative value depends upon its fertility, durability, and ease of cultivation. In these several respects, the soil of Miami is scarcely surpassed by any considerable areas in this or any other country.

Its *fertility* is abundantly indicated on the prairie by a rank growth of prairie grasses, rosin-weed, or compass plant, (*silphium laciniatum,*) prairie locust, (*amorpha fruticosa,*) and American hazel; and, in the forests, by the large growth of hackberry, elm, walnut, honey locust, wild cherry, ash, pignut hickory, sugar maple, and wild grape and plum; and is fully proved by the abundant crops of the staple articles, produced by the most ordinary cultivation.

The *durability* of this soil is fully established by its composition and depth, and the underlying beds of marl. As stated above, the fine siliceous marls of the Bluff Formation underlie and form the basis of the soils throughout this county. This marl, and the decayed animal and vegetable matter mixed with it, furnish an abundance of all the ingredients entering into the composition of the best soils.

Fields have long been in cultivation, with but little show of exhaustion. But the natural exhaustion of the surface soil by a long succession of crops, can easily be repaired by running the plow deeper, and bringing some of the virgin subsoil and marls to the surface.

By this process the deteriorated surface soil may be readily and effectually recuperated, and made as good as new; and, besides, there is rich material enough below to repeat this process upon as long as the present races will wish to cultivate. There is scarcely an acre of waste land in the county; the slopes are gentle, and the soil good to the tops of the highest ridges.

The characteristics above named show the soil to be light and easy of cultivation. It is nearly all open, clean, undulating prairie, without broken ravines or steep declivities, and entirely free from rock and stumps. There are a few places where the flints of Formation No. 8, of the above section, come near the surface and mingle with the soil, but the area is very limited, and may be used for pasture. The only real difficulty felt by the farmers in this part of the State, is the droughts which sometimes prevail in the summer months; but this difficulty can be entirely overcome, in all ordinary seasons, by deep subsoiling and early planting.

By a faithful use of the subsoil plow, every few years, the soil will be rendered light and porous to so great a depth that the roots will penetrate much deeper, beyond the reach of the drying suns, and the moisture will rise by capillary attraction, much more abundantly from the wet subsoil below. And, besides, the subsoiled land is so much lighter that the excess of water in early spring drains off much quicker, and the land can be worked and planted much earlier. By early planting the crops are more firmly established and fully de-

veloped before the droughts of summer come on. When thus advanced, they form a better protection to the soil against the drying heat of the sun, and have more power and depth of root to withstand its effects.

There have been many cases in the neighboring States where deep plowing and early planting secured excellent crops, while the crops in the adjoining fields, under the ordinary cultivation, were failures, through the excessive drought. We have seen several cases where the experiment was so successful, and the contrast so striking, that no one could fail to be convinced of the efficacy of the remedy.

It is also well established, by long and successful experiments, that deep or subsoil plowing* secures far better crops in ordinary and wet seasons, as well as in dry ones.

It is firmly believed that a rigorous application of this system of culture will secure good crops on the rich soils of Eastern Kansas, even in the *dryest seasons.*

SALT.

There are several dry salt licks in various parts of the county, but there are no indications to show whether valuable deposits of salt exist at those localities. Five wells have been bored at Osawatomie, in all of which good brine was obtained. According to the facts given us by W. B. Carter, Esq., the wells are 136, 270, 86, 120 and 115 feet, respectively, in depth. The first brine was struck in all at the depth of 60 feet, and at 80 feet a stronger vein of salt water was reached. These veins of brine were in the lower limestones of the above section, and were found at about the same levels in all of the wells, indicating a common origin in these rocks. But a careful examination of the limestones in which the brine was found in these wells, where they crop out in hundreds of places in the middle and southern portions of the county, did not reveal a single indication of the presence of salt, or salt water, rising from their beds.

* As a general rule the subsoil should not be turned on to the surface, but it should be stirred by a regular subsoil plow, (following in the furrow of a common plow,) leaving the subsoil in the bottom of the furrow, to be covered by the next furrow of the common plow.

The following section gives the rocks passed through in sinking the wells at Osawatomie, as given us by Mr. Carter:

No. 1.—22 feet, Soil and Clay. (Soil and Bluff Marls.)
No. 2.—9 feet, Soapstone. (Shales.)
No. 3.—13 feet, Blue Limestone and Clay.
No. 4.—45 feet, Gray Limestone and Clay parting. (Well Rock, Nos. 20, 21 and 22 of our section.)
No. 5.—Brine and Oil.
No. 6.—3 feet, Black Shale. (No. 23 of our section above.)
No. 7.—7 feet, White Limestone. (No. 26 of our section.)
No. 8.—170 feet, Soapstone. (Shales and Sandstone, No. 27 of our section.)

The strength of the brine ranges from $1\frac{1}{2}$ to $3\frac{3}{4}$ degs. of the Pennsylvania scale* for brine. The strength of the brine used for the manufacture of salt at this place averaged about 2 deg. of the above scale. The salt manufactured is esteemed a very pure article.

The works were not in operation when we visited them, and we could obtain neither salt nor brine. Dr. Sinks, the chemist of the survey, will analyze both, and give the results in his general report.

There is no doubt that other veins of salt water will be penetrated by sinking these wells deeper, but there are no means of determining at what depth the brine will be reached, or in what quantities, or of what strength it will be found; as no investigations have been made deeper than these wells, in this part of the State. There is, however, a probability that strong brine in large quantities will be reached at the base of the carboniferous rocks, where the numerous and bold brine springs in Central Missouri come to the surface. How deep this horizon is below the present borings we cannot tell till we have completed our survey of the southeastern part of Kansas, where we expect to find data for determining the thickness of the lowest carboniferous rocks in the State.

PETROLEUM.

The existence of "tar springs" in Missouri and Kansas, has long been known to the settlers and hunters of those re-

*20 deg. of this scale represents a saturated solution.

gions, but they attracted no particular attention, as the "rock tar" had been applied to no useful purposes, except as a lubricator of the freighter's wagon, and a limited application as a domestic medical remedy.

The late extensive application in the arts, has caused careful explorations of these localities to be made, which have resulted in discovering a vast number of places where petroleum comes to the surface through the rocks and soils in greater or less abundance. Such, in fact, is the abundance of petroleum flowing from the springs in this county, that no one can doubt that it comes from some abundant source.

In our examination of Miami county, more than twenty places were observed where petroleum flowed from the rocks and soils in considerable abundance. The larger number of these springs are, as shown on the accompanying map, on the Wea, Middle creek, Marais des Cygnes and Sugar creek. There are numerous places in all parts of the county where the rocks are saturated with petroleum, or contain it in their cavities in the solid state, called asphaltum. There are also numerous wells in which petroleum was found in some of its varieties. In some it was so abundant as to entirely ruin the water, and the wells were filled up and abandoned.

The most noted springs in the county are the "Wea Tar Spring," the "Beaver Tar Spring," the "Won-zop-peah Tar Spring," "Dale's Oil Spring," and "Honeywell's Oil Spring."

The *Wea Tar Spring* is on the Wea, in Sec. 2, T. 17, R. 24, and flows from the partings and crevices of the sandstone No. 17 of our section above, about 15 feet below the overlying limestone. This spring doubtless discharges more petroleum than any other in the county, and has been known to the settlers and freighters for more than thirty years, and to the Indians from time immemorial.

The *Beaver Creek Tar Spring* is in Sec. 8 of the same township, and springs from the same sandstone a few feet lower down, or 30 feet below the limestone No. 16.

Dale's Oil Spring is in Sec. 30, T. 17, R. 25, and comes up through the *Spring Rock*, from the sandstone below, or No. 17 of our section.

Honeywell's Oil Spring is in Sec. 33 of the same township,

and comes out through the fractures of the sandstone of No. 27 of our section, about 20 feet below the limestone No. 26. We saw some fifteen other springs from which oil flows more or less freely, and numerous places where the sandstones are completely saturated with it, and where the shales and limestones contain it in cavities. Oil also saturates the sandstone and comes up through the mud in several places in northeast quarter Sec. 31, T. 18, R. 24, on Godfrey's Branch. It also flows out of the bank of the Marais des Cygnes just above the mouth of that branch. The same sandstone crops out in nearly all the branches in this region, and is everywhere more or less impregnated with oil. At Sac Ford, in northwest quarter of Sec. 30, T. 19, R. 24, oil flows out of the bank on both sides of the river; also in several places in the ravines leading to the river, between Sac and Miami fords. And in a ravine west of the North Fork of Middle Creek in southeast quarter of Sec. 3, T. 19, R. 24, oil was obtained in a shallow excavation in No. 27. This sandstone crops out in many of the ravines in this region, and shows more or less signs of oil. Petroleum also flows from the soil in Mr. Gibbs's land, and in several other places on Middle creek below.

Some oil was obtained in the salt wells at Osawatomie, in several wells at Paola, in Dennis', Spence's, Lykins', and many other wells. Lykins' well was bored for oil in the southeast quarter of Sec. 15, T. 17, R. 23, in 1860, under the direction of Mr. G. W. Brown, for Messrs. Brown, Solomon & Co. We could get no very reliable account of the borings, as the records are reported lost. Mr. S. S. Clover gave us the following as the facts in the case according to the best of his recollection:

The well is 275 feet deep; 25 to 30 feet limestone, and the remainder sandstones and clays, with blue concretions containing pyrites which was said to have some gold in it. At the depth of 150 feet the clay with concretions was reached, 5 to 20 feet thick, and the last 50 feet was the same. "Got oil all the way down." It was supposed it would yield one barrel of oil per day, when the work closed on account of the troubles.

A St. Louis company, under the auspices of Mr. Einstein, has just commenced boring on Sec. 11, T. 17, R. 24. When we were there they had reached a depth of 110 feet, with some oil. The work is now in progress with fair prospects and high hopes of success.

These various oil springs and other indications of petroleum have their origin in four different sandstones, Nos. 10, 12, 17, and 27, of our section, as given above. Each of these sandstones is so saturated with petroleum in places that it runs out into the soil, or over the water, and fills the air with its peculiar odor; and where there are fractures or crevices, the oil flows out in such abundance as to have acquired the name of "Oil" or "Tar Springs." Some of these localities are mentioned in the descriptions of those sandstones in the section above. There are other localities in these sandstones in this county and Linn, and in Bates and Cass counties, over the line in Missouri, but enough have been given to show the character and abundance of these manifestations of petroleum in this region.

Nearly all the petroleum seen was of the dark, thick, heavy variety known in commerce as *Lubricating Oil*, which is much more valuable than the thin, amber-colored varieties.

The thin, amber-colored variety, Illuminating Oil, was seen in places on the water in the branches, and particularly on the springs, which come up through the surface marls and soils; and the solid variety, Asphaltum, was observed in numerous places in the cavities of the rocks and on the surface near the springs of the liquid varieties. Gas is more or less abundant at all the principal localities named.

Such are some of the facts observed during the examination of Miami county, and it would seem they are sufficient to convince any-one familiar with the indications and developments of petroleum in the productive oil regions of the country, that it must exist in large quantities in this county. The facts, that scarcely a well has been dug without finding petroleum in some of its forms; that four sandstones are in many places perfectly saturated with it; that more or less of it is found in the cavities of all the other rocks; and above all, that it has been flowing in considerable quantities from some

score of springs from time immemorial, are to say the least, very strong evidence of the existence of large reservoirs near these localities.

COAL.

There are two thin beds of coal in our section, No. 14 and No. 17, which crop out in several places in the county; but the other bed, No. 29, is too low in the series of rocks to come to the surface in this county. It was observed on Sugar creek, about three miles south of the county line.

The upper bed, No. 14, is not permanent, as in many places it runs entirely out. It crops out in several places in Secs. 18 and 19, T. 18, R. 22, and in T. 17, R. 24. Its thickness ranges from 4 to 10 inches, and its quality is scarcely medium. It has been worked some, but is too thin to pay. The bed in No. 17 is still less permanent, and is not so thick. It crops out in Sec. 30, T. 17, R. 22.

The only coal that can be worked to advantage in this county is No. 29, which crops out on Sugar creek. It is a bituminous coal of medium quality, 38 inches thick where we saw it on the west side of the creek, on John Ross' land. It is reported not so thick on the east side, on the land of the late Mr. Jacob Halderman.

This coal could be worked by shafts in any part of Miami county, unless by some very rare freak of nature it should thin out to the north and northwest. It will be an easy matter to approximate the depth at which it will be found in any part of the county. The only source of uncertainty in estimating the depth, rests in a variable thickness of some of the beds of sandstone and shales, as the limestones are very uniform in thickness; in the section we have given the extreme measurements, the thickest and thinnest parts so far as observed. Half of the sum of these extremes will give the average thickness, which is the thickness to be used in estimating the depth of any given bed below any other bed in the series.

If we wish to determine the depth of this coal bed at Paola, at the level of the big spring under the fort, we first determine which rock in the section comes to the surface on a level

with the spring, and then the average thickness of all the beds between that and the coal will give its depth near enough for all practical purposes. This spring comes out under the spring rock, No. 16. The rocks between it and the coal are Nos. 17 and 28 inclusive, whose average thickness is 307 feet, the depth of the coal of No. 29, below the level of the spring above named.

At the ford over Bull creek, west of Paola, the well rock, No. 20, is at the surface, and the average thickness of the beds, No. 20–28, between its surface and the coal, is 233 feet. In the same manner the depth of the coal may be determined at any other point.

As we remarked on page 16, it was impossible to determine the exact thickness of the sandstones and shales of No. 27, as a portion of it was covered up in Sugar creek, the only place where we saw the bottom of it. But we shall be able to do this when the survey of Linn county is completed. The approximate thickness given is near enough for all practical purposes of mining the coal beneath it, as a few feet more or less in a shaft will make but little difference in the expense of raising the coal, when the shaft is once completed.

When the amount of coal raised is considerable, one cent per bushel will cover all the difference in expense between raising it 200 feet, and raising it 300 feet.

The only practical question remaining, and which is by far the most important of all, is the amount that can be sold, and the price it can command. The price now demanded at the mine on Sugar creek, 25 cents per bushel, is high enough, provided any considerable amount can be sold at these figures.

The only question then, not settled with sufficient accuracy for all practical purposes, is whether this coal bed continues north and northwest in sufficient thickness to be worked to advantage, and this will soon be determined by the wells sunk for oil and salt in various parts of the country.

WATER.

But few portions of the country are as well supplied with water as Miami county. A glance at the map will show that

every part of it is intersected by creeks and rivers. A vast number of bold perennial springs flow from the rocks in all parts of the county. These supply their respective neighborhoods and fill the streams with a never-failing abundance of pure water.

TIMBER.

Timber is an item of primary importance in the prairie States of the West, and especially so in Kansas. But as indicated by the map, the streams in all parts of Miami county are skirted by magnificent forests of the very best timber of the deciduous species. There is an abundance for all farm purposes, and that, too, so distributed as to be convenient to every neighborhood.

Cottonwood, sycamore, honey locust, black and white walnut, white pignut and shellbark hickory, red and white elm, linn, red birch, white and blue ash, burr, white, chestnut, black, gray, post, red, pin and chinquapin oak, box-elder, mulberry, coffee-bean, persimmon, hop-hornbeam, grapes, hawes, wild plums, and other species of less importance, occur as large and well developed as usual in the timbered States of the West. With economy in the use, and ordinary care in preserving the timber, the county need never want for this article of primary necessity.

BUILDING MATERIALS.

Good limestone exists in sufficient quantities for buildings, fences, and all other farm and domestic purposes.

The gray limestone No. 11, and some of the beds of each of the limestones, Nos. 7, 9, 16 and 26, will burn into strong, white quick-lime, suitable for plastering and cements.

Clays suitable for brick are also found in various parts of the county. The upper beds of the Stanton limestone No. 7, and the white, soft beds of the well rock, No. 20, and some of the sandstone in the upper part of No. 27, make good fire rock, and are very suitable for fire places and chimneys, as they are easily worked and durable, whether exposed to weather or fire. These limestones are exposed in nearly all

parts of the county, and the sandstones in the southern part, on Sugar and Middle creeks, and other places where these formations crop out, as shown in the description of these rocks in the section above.

Some of the beds of Nos. 10 and 27 have a sharp grit and fine structure, very suitable for grindstones and whetstones. There is a fine locality south of Rockville, in the bluff of Sugar creek. Mr. Cameron had a good grindstone made from the sandstone of this locality.

FRUIT.

Apples, pears, peaches, cherries and plums, so far as tried, are doing well. They succeed well in the adjoining counties of Missouri, where the soil and climate are the same, and there is no good reason why they should not do as well in this county. With such improved modes of cultivation as are adapted to dry, rich soils, gooseberries, blackberries, raspberries and strawberries, and even currants may be cultivated with great success.

All the ground for fruit culture should be thoroughly and deeply sub-soiled; and that, in the small fruits above named, should be mulched with straw or prairie hay during the summer. All will do best on a northern exposure, and the currants should be on the north side of a fence, partially shaded by trees.

In a soil and climate so genial to the grape, it can scarcely fail of entire success. The ground should be deeply sub-soiled or trenched, and the vines carefully pruned, as the great trouble will be too rank a growth from the richness of the soil. But careful pruning, in view of the vigorous growth, will remedy the evils arising from this cause.

IRON ORE.

As noted above in the section, there are sundry beds of kidney ore—carbonate of iron—in the shale beds in the county. But they do not appear in sufficient quantities to be of any present practical value. The future may develop wants to which they will be suitable to supply.

POPULATION.

Miami county has a population of some 7,000, and is fast filling up with an enterprising population. Paola, the county seat, is a flourishing town in a beautiful location on Bull creek, near the center of the county. Osawatomie, St. Marysville, Stanton, Miami, Fontana, New Lancaster, Rockville and Beavertown, are pleasant centers of populations in various parts of the county. The various improvements, whether farms, houses, churches or schools, all indicate a thriving, energetic and prosperous people.

CLIMATE.

While Kansas has the temperature of Delaware, Maryland, Virginia, Kentucky and Missouri, and the southern parts of Ohio, Indiana and Illinois, the high, rolling surface in this part of the State renders the climate extremely pleasant and healthful.

It has been feared by some that Kansas is more subject to drouths than the older States in the Mississippi Valley, but a careful examination of the amount of rain in the various Western States, as given by the records kept at the military posts and other points, show that as much rain has fallen in Kansas for the last forty years as in Missouri, Illinois, Indiana, Ohio or Kentucky. We also have the testimony of the Indians, Missourians and others, who have lived in this State for the last thirty years or more, that there has been no serious drought in their memories, previous to 1860.

The following note from the *Head Chief* of the Kaskaskia, Peoria, Piankeshaw and Wea, confederate tribes, is a fair sample of the testimony collected from the old Indian farmers:

PAOLA, MIAMI COUNTY, KANSAS, Oct. 30th, 1865.

Prof. G. C. Swallow—Sir: I have cultivated my farm in this county for thirty-five years, and have raised good crops every year but one, A. D. 1860, and have had no serious injury from droughts previous to that year. The experience of other farmers in my tribes is the same as mine in respect to crops and droughts.

(Signed) BAPTISTE PEORIA.

We have thus the testimony of those who have lived here and cultivated farms, and the records kept at the military

posts, both showing that there had been no lack of rain in Kansas for at least thirty years previous to 1860, and that the drought of that year, and the partial one in 1864, are only such exceptions to the general rule as occur in all countries.

Such are the more important facts observed in our hasty examination of Miami county, and the most obvious practical application to be made by them in the economical pursuits of life. Some of the practical questions can be more definitely settled when the rest of the State shall have been examined; but enough is known and definitely stated to prove this one of the best agricultural regions in the Western country, with an abundant supply of water, timber and coal, and a fine prospect of a great source of wealth and prosperity in mineral oil.

We cannot conclude without expressing our grateful acknowledgments to the people of Miami county for their warm hospitalities and earnest co-operation in the survey, and for the facilities so liberally furnished to make our labors pleasant and successful.

It is scarcely possible to mention names without making invidious distinctions. Still, justice demands a public acknowledgment of the marked and enlightened liberality of the honorable members of the Board of County Commissioners, who provided funds for publishing a special report of their county; and of the citizens of Paola, who furnished the very best of transportation, and paid all expenses. The Survey is under special obligations to Hon. W. R. Wagstaff and Mr. S. S. Clover, who greatly facilitated our labors by being our constant guide, and by pointing out the most important localities. We are also indebted to Messrs. J. H. Pratt, A. G. McKenzie, G. W. Dale, W. Shiverly and others, for similar attentions. Such a people richly deserve the fair heritage they possess in their rich, beautiful Miami.

REPORT

OF

MAJOR F. HAWN,

ASSISTANT GEOLOGIST

INTRODUCTION.

LEAVENWORTH CITY, KANSAS, Dec. 20th, 1865.

PROF. G. C. SWALLOW, *State Geologist*,

SIR: The following report of counties examined by me, under your instructions, and not prosecuted under your immediate supervision, is respectfully submitted, with the sections illustrating the formations of that portion of the State assigned to my charge.

The details and unavoidable repetitions in the descriptions of equivalent formations recurring in different counties, will necessarily be tedious and generally uninteresting. But I at least hope that the various subjects have been presented in a manner to be fully understood.

Respectfully yours, &c.,

F. HAWN.

MAJOR HAWN'S REPORT.

BROWN COUNTY.

Area.—Brown county is bounded north by Nebraska Territory, east by Doniphan, south by Atchison and Jackson, and west by Nemaha counties, and contains nine hundred and twenty square miles, and is one of the northern tier of counties.

Topography.—Grasshopper takes its rise in the northwest corner of the county, and flows southeast out of the county, and the principal head branches occupy the southwest.

Walnut creek has its source near the center, and flows north, and crosses the north boundary near the middle. Wolf river heads in the northeast corner, and crosses the east boundary, a little south of the middle.

The surface of the southwest is broken, the remainder is a high, rolling and gently undulating prairie, well adapted to agricultural pursuits.

QUATERNARY SYSTEM.

This county does not afford sufficient data to treat this subject consecutively, nor has enough been collected elsewhere.

The records of this age are not so legible here, or in that portion of Kansas that came under my examination, as in some other portions of the Union, nor the periods so well defined. I have seen little or no evidence of the potent forces usually assigned to the Drift, unless the general landscape, and the scooping out of the outlines of our system of valleys in

the solid frame-work of the country is referable to this period, and even these are comparatively tame.

It may, however, be questioned whether even this was all accomplished during this period. At the base of the Tertiary, on our western slope, are what appear to be the remains of an ancient system of drainage, not unlike that of the present, in that vicinity. The most prominent is in the valley of the Republican fork, near the western boundary of the State, at an elevation of about 3,100 feet above the level of the ocean. It consists of the dry bed of a stream, over half a mile in width, with seemingly a northeastern trend. It was laid bare by denudations of the valley in which it is found, and is distinct from the bed of the Republican fork, as it contains debris, or rather boulders and gravel, (by which this phenomenon is recognized,) referable to primary and transition formations in the Rocky Mountains, immediately on the west, where this ancient stream had its source.

It seems a reasonable conclusion that these streams emptied into the ocean, whose level differed but little from the present, when we know that Tertiary formations are found on the lower Mississippi. Fluvatile communications must have existed between the higher and lower formations, and, in the flow, marked out the direction of our streams. The great Tertiary basin in our west, probably held the same relation to the ocean as our northern lakes now do.

After the close of the Drift period, or the modification of the earlier forces, little or nothing could have been added to the capacity of the valleys. The Bluff, or fine surface material, often constitutes the slope of the large rivers to their water's edge; and, more often, the troughs of the lesser streams; *vide* Second Missouri Geological Report, part I, pp. 67, 69, and part II.

Bluff.—This formation is the best defined deposit we have in this system.

With but little variation in mineral or physical properties, I find it covers hill, plain and dale. It covers the Tertiary and Cretaceous strata on our west, at an elevation of nearly five thousand feet above the level of the ocean, and, at lower

points, the Permian, and folds down over the Carboniferous, to eight hundred feet or less above the ocean.

Upon the conditions of the soil depends the substantial prosperity of all civilized nations. The mountains may yield their millions of glittering treasure; commerce and manufactures supply luxuries; but the country with a capacity to produce cheap and abundant food, has the elements for an independent, prosperous and happy people. This portion of our geology has received my earnest attention, for out of her soil Kansas must mainly work out her destiny.

In this county the Bluff Formation varies from 25 to 100 feet in thickness. It "presents a fine, pulverulent, obsoletely stratified mass of light, grayish-buff siliceous and slightly indurated marl." Where this is well developed, it yields, according to the analysis of the Missouri Geological survey:

77 per cent. of impalpable Sand.
13 per cent. of Alumina, &c.
3¾ per cent. of Lime.

This combination is all that could be desired for a substantial and permanent soil. In practice, it is found that this proportion of silica, (impalpable sand,) and alumina, (clay,) renders the soil friable and porous, readily absorbing any superabundant rain falling at the surface, and holding it in suspension, or store, from which the surface is supplied by capillary action; hence the capacity of the soil to resist the injurious effects of protracted droughts. In this process of retraction, the aqueous particles holding in solution fertilizing salts brought from beneath, are taken up by the roots of the growing plants, or, in the process of evaporation, left near the surface.

The magnitude of this vast storehouse of nature may be inferred from the depth of the deposits, equally fertile throughout all its parts, for the material thrown out of the shafts for wells, from depths beneath, is often more fertile than that at the surface. Nor is this county alone favored with this incomparable subsoil, for in every other county examined by me, its development is sufficient for all practical purposes, and in no instance will the percentage of lime fall below two and a half per cent.

Thus far I have discovered no "dead" subsoil, hard-pan or gravel.

The material of this formation is mostly composed of detritus of cretaceous formations, largely developed on the northwest, and composed of heavy beds of brown and gray marl, brown marl-stone, and gray and white limestone, the latter resembling chalk. Among the Bluff of this county I found fragments of this latter as large as a walnut.

Organic Remains.—The most prominent are those of the buffalo, (*Bison Americanus*).

At or near our western boundary, (Long. 102 deg. W.,) in a deep *arroyo* in the south slope of the Republican fork, elevated about 3,200 feet above the level of the ocean, and 125 feet above the stream, the following section occurs:

No. 1.—75 feet Bluff. At the surface was found a few specimens of *succinea ovalis*, and, at 50 feet below, bones of buffalo, (*Bison Americanus.*) These remains consist of a portion of the upper jaw, with five teeth; three *cervical vertebræ;* two *scapulæ*, (right and left); one *femur* and *coccyx*; all, probably, of the same animal.

No. 2.—15 feet or more brown and blue, soft, argillaceous slate, interspersed with thin plates of carbonate of iron. The ferruginous strata contain numerous fragments of casts of *Baculites;* one *B. ovatus*, and *Inoceramus convexus*.

In comparing the bones of the section, and many others found at different times, with skeletons of the modern buffalo found everywhere at the surface in this region, I proved their identity. I had a *femur* so well matched, that it would readily have been taken as belonging to the same skeleton, but for the color.

Soil.—After the foregoing, little need be said under this head. The accumulation of organic matters for ages, from the decay of a profuse annual crop of vegetation, grown on the marl, has produced a soil rich in those elements. In some parts of the county there is an excess of vegetable matter in the soil.

Bottom Soil.—Little or no difference exists between this species of soil, and that of the uplands. At some localities on the main stream, it contains more vegetable matter.

Rocks.—These are covered over 50 feet deep with Bluff, and it was scarcely possible to obtain anything like a regular con-

secutive section. Enough, however, was determined to refer them to the Carboniferous age, and Coal Measure period, and that they contain heavy beds of shale, sandstone, limestone and coal. The limestones afford some good building and fencing material.

Coal.—Three beds of coal are found in this county. The upper ranges from 14 inches to 2½ feet of good coal, but varies in quality in different localities. This bed crops out on Roy's creek, at the crossing of the upper road from White Cloud to Hiawatha, and is said to be 2½ feet thick. This locality has furnished coal for the surrounding country since the first settlement. The shaft was closed at the time of my visit. This bed is also worked on the west fork of Nemaha, and will be found over a large area of the county. This bed has a great lateral range, it being the equivalent of the Burlingame bed in Osage county.

The next bed varies from 50 to 100 feet below the first, in the vertical range. It crops out on Wolf river, at Kimberlin's coal bank, where it is said to be 3 feet thick and of good quality. This drift was submerged at the time of my visit. It is worked on the same stream, near Robinson, where it is 1½ feet thick, of medium quality. This is also extensively distributed over the county.

The next bed is some 200 feet below the latter, and is the equivalent of the Topeka bed. No out-crops were observed, but it should be found in the northeastern portion of the county. This bed is worked in the bluffs above Yankton, where it is some 20 inches thick and of excellent quality.

These beds, though thin, will afford an ample domestic supply of coal for all time to come.

Such beds are not generally appreciated—the unpracticed believing that they cannot be mined. This is an error. After an alley is formed for an out-crop of 1½ feet, a practical miner will deliver thirty bushels of coal per diem at its mouth, with all ease.

Salt.—A salt spring exists near Hamlin, on the premises of Mr. E. H. Niles. Its capacity is not known, but I should think the flow is some seven or eight gallons per minute. It yields two and a half per cent. of its weight in good fine salt.

After a careful examination of the formations in the vicinity, I came to the conclusion that this spring had its source beneath the surface. Such springs are of frequent occurrence in the State, making their appearance at different elevations in the vertical range, and have many things in common, tending to a belief that they are governed by a common impulse.

A company is now boring at Hamlin, with a view of reaching the parent source, or increasing the strength of the brine.

Timber.—Most of the streams are well skirted with good timber. Amongst the most valuable are several species of oaks, walnut and honey-locust, elms, linn, cottonwood and sycamore.

Smaller species—mulberry, box-elder, red-bud, pawpaw, buckeye, gooseberry, grape-vines and willows—fringe the streams.

Productions.—All the staples usually grown in this climate have been successfully raised in this county. This has been attended with profit, as the nature of the surface is so favorable for the working of all kinds of machinery, in the several stages of the crops, that the expense of labor is reduced forty per cent. or more. These latter remarks will also apply to the surface of nearly every county examined by me.

DONIPHAN COUNTY.

Area.—Doniphan county is bounded northeast and east by the Missouri river, south by Atchison and west by Brown counties, and contains about three hundred and eighty square miles.

Topography.—A large portion of the county lies in the bend of the river, curving irregularly eastward, with Elwood

at the apex. This bend gives the county an extensive river boundary, amounting to about sixty-eight miles.

Independence creek takes its rise in the southeast corner, and flows easterly into the Missouri river, at Doniphan. Wolf river enters the county about midway of the west boundary; flows east and north into the Missouri river about eight miles below White Cloud. Cedar creek heads near Highland, and runs north and east into the Missouri river at Iowa Point.

The bluffs of the Missouri river are washed by that stream at some points, and at others the stream recedes, and extensive bottom lands intervene. Most of these lands are sufficiently high above the stream to exempt them from inundation.

The bluffs vary from fifty to two hundred feet in height, sometimes abrupt, broken and rocky, and others more assimilated to a high rolling prairie, and adapted to cultivation. By far the largest area of the county varies from a high, rolling prairie to gentle undulations, both pleasing to the eye and convenient to the agriculturist. Those who are fond of gentle, quiet landscapes, can here be indulged in the months of May, when the prairies are dressed in their floral garbs. The plow, however, has made sad encroachments; but a few years and Ceres will reign triumphant.

Bluff.—This formation contains all the elements and depth of that in Brown county, and all that is there reported applies in an eminent degree to this.

Soil.—The soil and bluff formation, or sub-soil, are so closely allied that to know the one is a knowledge of the other. The soil of the uplands is all that could be desired, and in every respect like that of the eastern portion of Brown county.

Bottom Soils.—The Missouri river bottoms are everywhere proverbial for their fertility, and those in this county are by no means an exception.

Rocks.—The bluffs along the river below White Cloud, are composed of heavy beds of limestone, shales and sandstone. The limestone makes excellent building and fencing material. These formations constitute the upper portion of the Missouri

river section of the Geological Survey of the State of Missouri.

The formations in the interior are so deeply covered over that but little could be observed in detail. Enough, however, was determined to know that some one hundred and fifty feet or more of shales, sandstone, thin beds of limestone and coal, are immediately above those formations in the bluffs of the Missouri river.

The horizontality has been somewhat changed from the original position. In the upper portion of the county, I find an inclination in the strata too great to reconcile with the popular theory of coal formations. The dip brings down to the water's edge in the Missouri river, at White Cloud, the base of the formations noted in the interior and above the rocks in the bluffs of the Missouri river at and below Iowa Point.

The two lower beds of coal in Brown county should also be found in this. In consequence of the great depth of the bluff formation, but few outcrops occur.

Timber.—The bottoms along the Missouri river are mostly timbered. The most valuable are burr oak and black walnut, which attain an immense growth. In addition to these are several other species of oaks, elm, cottonwood, honey locust, hackberry, hickory, coffee tree, linn, &c. Some portions of the bluffs are sometimes grown over with oaks and hickory.

The streams of the interior are also well timbered with most of the preceding species.

Productions.—All the staples of this parallel have succeeded in this county, and are considered reliable crops, and with ordinary tillage yield abundantly.

Apples and grapes have also succeeded well in most localities where they have been tested. My observations in this State, and others in the West, leads me to believe that southern exposures for fruit should be avoided, as well as deep valleys.

This matter of southern exposures may be a judicious preference in the northeast, where the climate is radically different from ours here. The former is more frigid but less versatile, with a much lower range of temperature; shorter summers, with less of autumn, and hence the necessity of

occupying such positions as will give them the best advantages in the absorbtion of heat. With Kansas it is different. Summer heat never passes away until our fruits have all ripened or matured. With this view of the subject, a southern exposure can have no advantage over a northern, especially as the temperature of the air is of itself sufficient for that purpose, without aid of the direct rays of the sun. Southern exposures are undoubtedly pernicious in our climate for these reasons.

The roots of trees grown on our deep, rich, porous subsoil penetrate the earth to a great depth. The roots of indigenous trees are often found at the depth of twenty feet below the surface. It will readily be seen that roots lying below the influence of atmospheric changes, are constantly urging their sap to the surface, and upon a favorable condition above, in the winter, send it to the branches and buds.

The apple tree particularly responds to such changes, for it is an exotic of a colder and more steadfast climate. Such favorable conditions are constantly occurring during the warm days of our genial winters, succeeded by nights of cold and hard frosts, freezing and vitiating the sap sent up the day previous, to the injury of the tree. These deleterious effects may be modified, if not not counteracted, by selecting northern slopes or hill summits for the orchard.

The temperature between day and night on northern slopes is more in equilibrium, in consequence of being less under the influence of the solar rays and having a freer circulation of air on the hilltop. The healthiest and most prolific trees are found in such locations.

I am induced to believe that when the matter has been more thoroughly investigated and amplified, that this theory will also apply to most of our cereals.

CHASE COUNTY.

Area.—This county is bounded north by Morris, east by Lyon, south by Butler, and west by Marion counties, and contains five hundred and seventy-six square miles.

Topography.—The Cottonwood runs northeast and east, nearly through the middle of the county. Middle creek flows in from the westward, and Diamond creek from the northwest corner, and empty into the Cottonwood, near the center of the county. South Fork heads beyond the south line, and runs north through the east half, and flows into the Cottonwood seven miles west of the east boundary.

The surface of the northwest quarter is broken by indentations of Middle and Diamond creeks. The northeast quarter is high, rolling prairie. The tier of townships on the south line is broken, and the residue varies from broken to high rolling, and gently undulating prairie.

The bottoms on the Cottonwood vary from two to three miles in width, and those of the smaller streams from one-half to one mile and a half.

GEOLOGY.

Bluff.—This formation is like that of Lyon county, with the exception that probably here it is impregnated with sulphate of lime, derived from the gypsous shale formations of the county.

Soil.—The bluff, or subsoil, and soil, are but parts of one common whole, the latter dependent on the former for its inherent properties. When, then, the bluff formation is well developed, the soil must be good.

Bottoms.—The soil of Cottonwood bottom is the same in characteristics as in the county of Lyon. The soils on the bottoms of the lesser streams partake more of the nature of the uplands, but contain more vegetable matter. These latter are better adapted to the production of the cereals, as the superabundance of decomposed vegetation of the former predisposes to a rank growth of straw at the expense of the grain. This, however, is not a disadvantage, as grass and hay are now the elements of the farmers' prosperity, and the Cottonwood bottoms produce these in an eminent degree.

Rocks.—The solid formations of the county belong to the Permian System. They are composed of heavy beds of magnesian, cherty limestone, shales and gypseous clays. The limestone affords an excellent building material and for fences, and is abundant in all the abrupt slopes, and the gypsous clays have added much to the soil. These clays, as well as extensive formations of gypsum, are incorporated with this system of rocks, both in Europe and the United States.

In Kansas, in the valley of the Smoky Hill fork, these formations attain a depth of fifty feet or more, covering large areas. At some points these beds have been washed away by a flood that once overspread this portion of the continent. These waters carried the detritus of the gypsum forward in a northeasterly direction, mixed it with other matters coming from farther north, and deposited the sediment over the surface, and produced the superficial formation denominated bluff, to which frequent reference is made.

When gypsum is in due proportion in the bluff, the circumstance may be detected in an extraordinary growth of a a peculiar kind of grass, known as bluejoint.

Gypsum has a world-wide reputation as a fertilizer, and seems to be more beneficial to some crops or plants than others. In specifying, I would remark that extraordinary yields of sorghum have been claimed in several localities where gypsum is present in the soil. The physical surroundings afforded no other solution to these seeming exceptions. Various influences on the vegetable economy and functions of plants have been assigned to this mineral.

According to Koller, the action of gypsum depends upon the power possessed by the lime to form with the oxygen and carbon of the atmosphere compounds which are favorable to vegetation. According to Rukert, it acts like any other food. According to Mayer, and Brown, it merely improves the physical properties of the soil; while according to Keil, it is an essential constituent of the plant. Hedwig called gypsum the saliva and gastric juice of plants. Humboldt, Girtaner and Albert Thaer consider it as a stimulant by which the circulation of plants is promoted; and Chaptal ascribes

its action to a supposed power of supplying water and carbonic acid to plants. Davy regarded it as an essential constituent of plants, because it acts only when gypsum is wanting in the soil, while other English agriculturists have supposed it to promote fermentation in the soil. According to Laubender, it acts as an exciting power without mixing itself with the sap of the plant. According to Liebig, it fixes the ammonia of the atmosphere, and according to Braconnot and Sprengel, it supplies sulphur for the formation of the legumi of the leguminous plants. Johnson, the celebrated English agricultural chemist, also corroborates this latter view.

Lead.—Specimens of "float mineral," (sulphate of lead,) have been found on the premises of Gen. S. N. Wood. Its origin or fissure is unknown, but the condition of the rocks in the vicinity are not unfavorable to its existence. The strata have been considerably disarranged by internal action that produced dips amounting to two hundred feet per mile. The most prominent are toward the northeast, and exhibit faults and fractures to a considerable extent. These dips form synclinal axes at Cottonwood Falls.

Timber.—Belts of a good growth of timber occur along all the streams. Black walnut, oak and elm are the most numerous species. In addition to these are hickory, hackberry, cottonwood and sycamore. The lesser species are grapevines, redbud, buckeye, rose, &c.

Productions.—See Lyon county.

Climate.—See Lyon county.

Health.—See Lyon county.

LINN COUNTY.

Area.—Linn county is bounded north by Miami county, east by the State of Missouri, south by Bourbon county, and

west by Anderson county, and contains six hundred square miles.

Topography.—Marais des Cygnes runs through the northeast corner. This stream has high bluffs, and broad bottoms, often two miles and a half in width.

Sugar creek flows east through the middle of the county, and forms a junction with the Marais des Cygnes near the eastern border.

Little Sugar creek heads in the south half of the county, flows east and north into the Marais des Cygnes four miles west of the State line.

The surface in the valleys of Sugar creek and Little Sugar is generally broken. The remainder is a high, rolling prairie, except the bottoms of Sugar creek, which are broad, level and not generally liable to inundation. The bottoms, on the lower portions of Sugar creek, are often a mile in width.

In the southeast portion of the county, in the vicinity of the State line, the country is broken into high mounds. Here are evidences of Plutonic action in a disturbance of the parallelism of the strata and partial change of color by heat in some of the formations. These effects are also visible in the center of the county, in the vicinity of Mound City, where fractures were observed in limestone formations, constituting the ford of Little Sugar creek.

Bluff.—In the north portion of the county the formation is well developed, and of the nature of that of Miami county. Towards the south, it is thinner, but of sufficient depth for all practical purposes.

Soil.—The soil is of a good and productive character throughout the county. It varies but little from that of Miami county.

Bottom Soils.—These are of the usual character, strong in organic remains. On Sugar creek, rather tenacious, but fertile and durable.

Rocks.—The solid strata of this county belong to the carboniferous age and coal measure epoch. The formations are like those of Bourbon county, affording good limestone and sandstone for building and fencing material.

Coal.—The bed of coal at the base of the Miami Section

should be found in the northern and western portion of the county, and is equivalent to No. 12, Missouri river section. The upper bed reported in Bourbon county is found at Mound City. The second coal bed, in descending order in Bourbon county, is found near the crossing of the old Military road and Mine creek, and two miles east of that. The third (?) is on Indian creek, three miles east of the old Military road. These beds will supply the county with all needful fuel.

Lead.—Lead is found near Potosi, on Mine creek, in connection with evident Plutonic action. It is found in fissures in sandstone. These sandstones have evidently undergone a change in color. The formation at one locality is thirty feet thick, and is of nearly a brick red, with the exception of about four feet of the surface, which is of light gray. At another point three miles southeast of this phenomena, was observed as high as No. 18 of the Missouri river Section. Here the limestone and shale are changed in color and texture, except near the surface, where it appears as if the heating vapors were suddenly arrested. This point is over one hundred feet above the brick-red sandstone.

In the limestone formations referred to, are small vertical fissures, lined with large crystals of carbonate of lime and particles of carbonaceous matter brought up from below. These effects are local in their character, for in close proximity is a bed of bituminous coal not affected.

Salt.—In the vicinity of Mound City is a well of brackish or salt water.

Timber.—This county is well supplied with timber. With the heavy belts of timber on the streams, the bluffs are often well grown with timber. This is particularly the case with the western and central portions of the county. On the bottoms occur sugar maple, black walnut, elm, oak, linn, &c. On the bluffs, principally oak and hickory.

Productions.—Wheat, rye, oats, Indian corn, and most other crops of this climate succeed well in this county.

GREENWOOD COUNTY.

Area.—This county is bounded north by Lyon, east by Woodson, south by Seward, and west by Butler, and contains about one thousand square miles, and is one of the southern tier of organized counties.

Topography.—The Verdigris runs through the eastern portion of the county, and Fall river through the south half, flowing from the northwest to the southeast, and empties into the former, about twenty miles south of the southern boundary of the county.

The valley of the Verdigris is about one and a half miles in width on the north boundary, and toward the south frequently two miles. The slopes on the right side of the valley are more abrupt than on the left; the bottoms are level, high, and no large portions of them subject to overflow, and vary from one and a half to two miles in width.

Where Fall river enters the county, the valley becomes spacious, sometimes several miles in width. The slopes are gentle, undulating, and presenting pleasing though subdued landscapes. The bottoms are often two miles broad, uniform in surface, and usually above high water mark.

The surface between the streams where they are in close proximity, and at the heads of some of the branches, is broken, the remainder a high, rolling prairie.

GEOLOGY.

Bluff.—This formation in the northern portion of the county differs but little from that of Butler county. In the south half it is more sandy, and probably has less sulphate of lime.

Soil.—Like the Bluff, in the northern half of the county it is not unlike that of Butler county, but in the southern portion it is more sandy, but sufficiently fertile to produce good crops of grass, and for some purposes superior to that of the north.

Bottoms.—The soil, on the extensive bottoms of the Verdigris and Fall river, is a rich alluvion, with a large percent-

age of organic matters that have been accumulating for ages from the rank, annual growth and decay of vegetation.

Rocks.—The underlying, solid strata of the county are of the Carboniferous Age and of the Coal Measure epoch, except a small portion in the northwest, which belong to the Permian Age.

The section exhibits extensive formations of sandstone and shale in the south. These several formations are largely in excess of their equivalents in Miami county, and the lowest limestone is the equivalent of No. 1 of the Missouri river Section.—*Vide* 2, *Mo. Report, part* 1, *page* 78.

Coal.—Several beds of coal are found in the valley of the Verdigris. On Wilhite's creek, in section 18, township 24, range 13, east, near Verdigris Falls, and at the mouth of Rock creek, near the northern boundary of the county. These occur mostly in the beds of creeks, and were submerged so that I could not ascertain their volume or quality, nor have they been properly opened to judge of either. These strata should also exist on Fall river.

Petroleum.—Throughout the entire valley of the Verdigris, strong indications occur of the existence of this popular fluid. Scarcely a puddle of water was observed on the right slope of the valley that did not reflect the rainbow colors. The most prominent of these occurred in the high bluffs three miles and a half below Pleasant Grove. These indications often occur over sandstone and sandy shales that present a volume of over two hundred feet, and are the equivalent of the oil-bearing rocks of Miami county.

Salt.—Toward the south boundary of the county, on the right side of the valley of Fall river, is a brine spring. Its source could not be determined, but it comes to the surface about fifty feet below No. 1 of the Missouri river Section,—[*Vide* 2, Mo. Report, part 1, page 78,] and is known in the Miami county survey as "Well Rock."

At the time of my visit, the water of the creek interfered with a proper determination of its character and capacity, but I learned through various persons that it discharged about nine gallons per minute, and a gallon of brine yields three ounces of salt. Many persons of the surrounding country resorted

to this spring in times past, to manufacture their annual supply of salt.

Timber.—In the lower portions of the county, timber is abundant in the valley of the Verdigris and Fall river. The species consist of a fair growth of black walnut, oak, elm, hickory, hackberry, and a few cottonwoods and sycamores. At some points the bluffs are sparsely covered with a stinted growth of pin and jack oaks. In the upper half of the valleys, the belts of timber along the streams are not as wide, but the growth and variety are about the same. The smaller species are redbud, grape-vines, mulberry, gooseberry, sumac, prickly ash, rose, &c.

Productions.—Wheat, rye and oats are cultivated with success. In this, as well as all matters pertaining to this head, the report of Butler county also applies to this county.

Climate.—This county lies within the same parallels as Butler county, and joins it on the east, and having many things in common, the report of Butler applies equally well to this.

LYON COUNTY.

Area.—This county is bounded north by Wabaunsee, east by Osage and Coffey, south by Greenwood, and west by Chase and Morris counties, and contains nine hundred and fifty-eight square miles.

Topography.—The Neosho flows southeast, nearly through the middle of the county. The Cottonwood runs nearly due east through the south half, and joins the Neosho on the eastern border. These streams have broad bottoms, varying from two to four miles in width. Osage river heads in the northeast corner, but their valleys are but slight undulations. The

northern portion is a high, rolling and gently undulating prairie. The south border is broken by the branches of the Verdigris.

GEOLOGY.

Bluff.—This formation is peculiarly well developed in this county. It sometimes attains the depth of fifty feet. Indeed, so well are the solid strata covered over by this that it is possible only to obtain a glimpse of this division of the geology. This formation differs from that of Butler county. It is more tenacious, higher colored, contains more iron, and is of a coarser texture. It resembles more the same formation on the Missouri river and in Miami county.

Soil.—Judging from the exuberant vegetation, the soil of this county is inferior to none in the State. On the uplands, it is rarely less than two feet, and often four and five, consisting of a due mixture of the bluff marl and decomposed vegetation. The latter is the accumulation of ages by the growth and decay of plants, stimulated into plethora by the subsoil, a silicious marl that would be invaluable for a surface dressing in some parts of the Union.

Bottoms.—The soil of the lowlands, or river and creek bottoms, is also rich in organic remains, perhaps more so than the uplands. The subsoil is the result of fluvatile action, which brought with it the wash of the hills and much of the vegetable matters of their tributary streams.

Rocks.—Enough only was seen of the solid strata of the county to determine their difference and approximate boundary. They belong to two different ages, the Permian and Carboniferous, of Coal Measure period. Their limits may be nearly determined by drawing a line through the county from the northwest corner to the southeast, and assigning the southwest half to the Permian, and the northeast to the Carboniferous.

Timber.—Most of the principal streams are skirted with timber, such as oak, black walnut, elm, cottonwood, sycamore, &c. The smaller species are sumac, redbud, buckeye, grape vines, goosberries, &c.

Productions.—Nearly all the cereals incident to this climate

have been successfully cultivated in this county. In addition to this, sorghum is under extensive experiment, and thus far promises well.

Climate.—There can be but little difference in this respect between this county and those of Butler and Greenwood. Judging from the character of the plants, this county receives a greater annual amount of rain than the latter.

Health.—In this respect the uplands are all that could be wished, and will compare favorably with the older States. Bottom locations do not differ materially from the uplands. Notwithstanding the extensive areas covered with rank vegetation going to decay, but little corresponding disease is engendered.

Pure water may be obtained anywhere by digging from fifteen to thirty feet.

BUTLER COUNTY.

GEOGRAPHY.

Area.—This county has a surface of seven hundred and twenty square miles, in a rectangular form, comprising congressional townships 22, 23, 24 and 25, south of the base line and between ranges 5, 6, 7 and 8, east of the sixth principal meridian. The south boundary is one hundred and fifty miles south of the Nebraska line.

Topography.—Four streams take their rise within this county. The South Fork and branch of the Cottonwood flowing north, and Walnut and Fall rivers running south.

The valleys of these streams are large in proportion to the size of the streams, and those tending south are more uniform, wider, and not so deep as those descending north, and this remark applies generally to the surface fractures of the State.

The surface of the upper portions of the valley of Fall river is much broken; the bottoms vary from one-fourth to one-half mile in width, and partake much of the character of the uplands.

The valley of the Walnut differs from that of Fall river in a more uniformity of surface, and is not so deep.

GEOLOGY.

Bluff.—This formation is sufficiently developed for all practical purposes, constituting a subsoil of from three to ten feet deep, of rich friable marl, containing all the elements of productive and durable soil. Analysis will probably show that this formation has incorporated with it a large percentage of sulphate of lime, transported hither in the shape of detritus from the great gypsum deposits on the northwest, and from the shales of the underlying rocks. This is the only formation of the superficial deposits.

Soil.—The foregoing rich deposit produced its annual crop of native grass, which, in turn, decayed and added other valuable ingredients, and this repetition continued for successive ages, and produced a soil from one and a half to four feet deep. This soil only differs from the subsoil in having a large amount of vegetable matter incorporated with it.

Permian Rocks.—Formations of the Permian age constitute the solid frame-work of the county, except a small portion in the northeast corner, which is Carboniferous. They are mostly composed of magnesian limestone, gypsous, pyritiferous clays, and argillaceous shales.

The limestones are generally good for building, and for fencing. They may be rendered available in the abrupt slopes, and the supply will be nearly equal to the demand.

The disintegrated gypsums and pyritiferous clays add much to the capacity of the soil.

Timber.—Along the streams, generally, are belts of timber, consisting of a good growth of elm, black walnut, hickory, hackberry, oak, and a few cottonwoods and sycamores. Among the smaller species are red-bud, mulberry, box-elder and grape vines.

Productions.—Thus far, farms have only been opened and cultivated on bottom lands. On these, wheat, rye, oats and barley are considered sure and abundant crops.

These crops, however, sink into a secondary consideration when compared with the natural pasturage. Upon the rich, native grasses, cattle feed the year round. In this mild and genial climate, little or no provision need be made for feeding stock through the winter. The grass cured by the hand of nature is generally sufficient for this purpose, as the winters are comparatively free from snow and rain, leaving this natural hay but little exposed to deterioration. In any event, a sufficient quantity of grass may be cut and cured, with but little outlay, for the natural meadows are thickly set, and so uniform in surface that there is scarcely a pebble to interfere with the operations of a machine mower.

Of the nutricious quality of the indigenous grasses, no one need be mistaken who examines a herd of cattle after the month of May. It is then a rare thing to see a healthy animal low in flesh.

Climate.—The mean temperature of the summers probably differs but little from localities within the same parallels farther east.

The winters are short and mild, with little or no rain or snow. Most of the rain falls between the months of March and July, and is always sufficient to mature the earlier crops.

Health.—From the foregoing, it will naturally be inferred that this is a healthy region. An experience of eight years of settlement proves that it is all that could be desired in this respect.

Water.—Excellent and abundant supplies of water may be obtained by digging from ten to thirty feet.

Remarks.—It is apparent from the foregoing, that the great agricultural interests of this region are closely blended, for the present, with the growth of the natural grasses. Steps should be taken to nurture and preserve their growth from useless and deleterious influences.

The reprehensible practice of making "late burns" should cease at once. This practice of destroying the current growth

by burning the dead grass of last season, with the close feeding on the after-growth, weakens the germ and growth of each year, and if this is repeated at short intervals, will finally destroy the roots. These suggestions are peculiarly applicable to portions intended for or devoted to meadows. This variety of land is often confined to river and creek bottoms, and is sometimes of limited area. At such localities it consequently has an intrinsic value, so long as it re-produces its luxuriant crops. Destroy this combination, and I know of no exotic that can take the place of the indigenous grasses. Immediate measures should be instituted to preserve this species of land intact.

Fires should be prohibited after the first of March, not only to preserve the meadows, but also to protect the timber.

Burning, at any period, is destructive enough to this species of natural production, but peculiarly so after the sap is in full flow, when it is either fatal to the young tree or inflicts an injury that retards its growth, and prevents a full development into a healthy tree.

OSAGE COUNTY.

Area.—Osage county is bounded north by Shawnee, east by Douglas and Franklin, south by Coffey, and west by Lyon and Wabaunsee counties, and contains seven hundred and ninety-two square miles.

Topography.—Few counties have so regularly diversified a surface as this. From near the middle of the east boundary, the Osage spreads out her tributaries north, west, south and east, not unlike a fan, and watering the county in an admirable manner.

These tributaries have each their system of smaller valleys,

often beautiful, and, in addition, diversifying the surface into high, rolling prairies, wavy undulations and gentle slopes.

Each of these branches have well-defined bottoms, which are often broad. Those on the principal streams are sometimes one mile and a half in width.

The great Santa Fe road runs through the northern part of the county.

GEOLOGY.

Bluff.—This formation is well developed, and is in every respect like that of Lyon county.

Soil.—The soil of this county will compare favorably with that of Lyon, and has no peculiarity distinct from the eastern portion of it.

Bottoms.—The soil of the bottoms of the principal stream has a large amount of humus incorporated with it; that of the tributaries is more like the soil of the uplands.

Rocks.—The solid frame-work of the county belongs to the Carboniferous age, and Coal Measure epoch. It consists of shales, limestone, sandstone and coal.

The limestones crop out in nearly every valley and ravine, affording an abundant supply of good building and fencing material.

Coal.—That portion of the Coal Measures developed in this county has one workable bed of coal. It crops out near Burlingame, where it is extensively mined, and furnishes the country for some distance around.

It varies from 18 to 28 inches in thickness, and, when first mined, is of a lustrous brown, shading into black. It is composed of compact parallel plates, with a semi-conchoidal fracture. It burns freely, and, when free from pyrites, is an excellent coal.

This bed will be available over a large portion of the county. By a dip in the direction of the fall of Dragoon creek, nearly equal to the fall of the stream, this stratum will be found in the valley either from outcrops or at a depth of a few feet. If persistent, it will be found on the main stream up as far as the west boundary.

Timber.—Wide belts and large groves of excellent timber

occur on the main stream, consisting of a magnificent growth of burr and other oaks, black walnut, elm, hackberry, linn, hickory, ash, and a few cottonwoods and sycamores.

The smaller species are box-elder, mulberry, buckeye, redbud, pawpaw, hazel, wild plum, rose, gooseberry and willow fringing the streams. Most of the tributaries are also well timbered.

MORRIS COUNTY.

Area.—This county is bounded north by Davis, east by Wabaunsee and Lyon, south by Chase, and west by Marion and Dickinson, and contains about six hundred and seventy square miles.

Topography.—Neosho heads in the northeast portion of the county, and runs out at the southeast corner. Towards the head of the stream, and in the southest corner, the surface is broken, but the remainder of the county is a high, rolling and gently undulating prairie.

The bottoms on the creek are about three-fourths of a mile in width, and grow narrower towards its head.

GEOLOGY.

Bluff.—This formation is in many respects like that of Chase county. On the northwest and west it comes more under the immediate influence of the gypsum beds, situated in close proximity. It is rarely less than 25 feet deep, except on slopes of abrupt valleys.

Soil.—On the uplands, in the northwest and west, the soil is unsurpassed, and throughout the county it is all that could be desired; nor can it ever be less, even under the most extraordinary tillage. It would require a protracted period of close cropping to affect the soil seriously, and all that would

then be required to renew the soil in its pristine vigor, would be to set the plow a few inches deeper, and turn up the virgin bluff, with its fertilizing elements.

Bottoms.—These differ but little from the uplands, except that, like most of the other valleys, they contain more humus.

Rocks.—The older formations of the county are so effectually covered over with the Bluff or superficial deposits, that little else could be ascertained than that the rocks belong to the Permian age; the upper divisions of which were observed in the northern and western portions.

Portions of these formations crop out at Council Grove and vicinity, where they constitute an excellent building material, and may be advantageously used in fencing.

Timber.—The Neosho and its principal tributaries have belts and groves of timber, such as oaks, black walnut, elm, ash, hackberry, hickory, cottonwood, grape-vines, &c.

Productions.—Wheat, rye, oats and Indian corn have been successfully cultivated, and sorghum in small quantities.

Climate.—The winters are dry, with but little snow or rain, with a large proportion of clear, sunny days.

Health.—The health of this county has been uniformly good, since the earliest settlement.

Water.—Pure water is abundant.

REPORT

ON THE

SANITARY RELATIONS

OF THE

STATE OF KANSAS.

BY

C. A. LOGAN, M. D.

INTRODUCTION.

LEAVENWORTH CITY, KANSAS, Dec. 1st, 1865.

PROF. G. C. SWALLOW, *State Geologist*,

DEAR SIR:—In the organization of your geological corps, you erected a department devoted to the Sanitary Relations of the State, and requested me to preside over it.

The idea of linking together, in one movement, two subjects so closely allied, the one with the material interests of man, and the other with his health and life, is not only entirely new, but eminently proper and praiseworthy.

Comprehending the enlarged spirit which prompted the inauguration of so important a movement in our new State, I have felt it my duty to accept the proffered position, and have made such a report as my leisure and the nature of the subject have permitted.

A little reflection, however, will reveal the fact that this cannot be, properly, a report on the Sanitary Relations of the State.

The Sanitary Relations of a State, in general terms, may be said to be those conditions, either of atmospheric influence, physical conformation, or habits of life, which affect the health of the people, collectively and individually, either favorably or unfavorably. The knowledge of such conditions can best be ascertained through the agency of a *Sanitary Survey*.

To obtain some idea of the amount of time and labor necessarily consumed in making such a survey, it may be stated in the words of a committee of the Massachusetts State Medical Association, that it should be the object of a sanitary survey, "to ascertain the hygienic resources and influences of the State; to know the amount of vitality, of life and

health enjoyed by the people; to learn whether there are any differences in regard to life and health among the people, and what those differences are." Having become acquainted with these facts, it will readily suggest itself, that these are but the first steps in an inquiry, which has for its direct purpose an object so important to the general welfare. It follows that the next measure would be to open up the chain of causes which might be in operation, either throughout the whole State, or in a particular district of the State, to produce a low per centum of vitality, of life and health among the people. Here the field of inquiry would enlarge and send a communicating road into almost every branch of science. Among the questions to be solved in such a connection, are those relating to the *Climatology*, embracing the temperature; the average fall of rain and snow during each month and each year; the prevalence and direction of the winds, &c., &c.; those relating to the *physical aspect* of the State, in its parts and in the whole, embracing its hydrography or drainage, with the considerations of the size and extent of its watercourses and its water-sheds, breadth of river bottom, and quantity of marshy or springy soil; the *topography*, embracing the questions of area and altitude, location and size of principal towns, general character of surface, principal valleys and eminences, amount of surface under cultivation, with amount, character and location of timber; the *geology* in its bearings upon the geological position, actual location, dip, direction and extent of the different formations; character of soil, subsoil and subjacent rocks; source and nature of water used for domestic purposes; and, finally, those relating to the *habits and mode of life* of the people themselves. Under this latter head would come the consideration of those circumstances connected with the daily life of man,—his occupation, his residence, either in the pure air of the country or in the vitiated atmosphere of an over-crowded and unhealthy city; his abode, whether cleanly and ventilated, or foul and unventilated; in short, everything, either external to man, or connected with his own person, which may affect deleteriously his health and life.

The satisfactory compilation of such a work, requires not

only time and labor, and the compilation of mortuary statistics, but is necessarily attended with much expense. The Legislature, as yet, has not authorized a survey to be made with a view to determining the sanitary relations of the State, nor appropriated the sum necessary to defray the expense.

From these considerations, it will appear that this report is not a systematic and exhaustive essay upon the subject. Its immediate object will be to awaken our people and our legislators to the great necessity of laws for the promotion of public and private health; and, in the furtherance of this object, the subject of Hygiene or Health will be treated of as fully as possible, and the sanitary relations of the State, so far as they have been ascertained, will be set forth.

As the subject is of vital concern to every one, whether professional or unprofessional, it is proper that the language should be stripped of technicalities so far as possible, that it may be adapted to the comprehension of every intelligent person. For the same reason, it has not been thought amiss to depart from the systematic arrangement belonging to professional essays, where perspicuity to the popular reader might seem to demand it.

That it is imperfect in many of its features, I am fully sensible; but if it shall accomplish the one object of drawing attention to a subject which has so prominently occupied the attention of the scientific world for the past forty years, whereby measures may be taken to put a State just entering upon a career of commercial greatness, upon a *health-footing*, I shall have done all that may be done as a preliminary movement.

Respectfully yours,

C. A. LOGAN.

DR. C. A. LOGAN'S REPORT.

HISTORICAL SKETCH OF THE SUBJECT.

In all ages of the world, it has been the first great desire of man to enjoy the blessings of health, and to reap the pleasures of longevity. In a sound and healthful condition of mind, there can be no exception to the truth of this observation. With this purpose in view, every man, however little he may be versed in the science of human health, forms for himself certain ideas, and digests therefrom certain principles in regard to the maintenance of his corporeal well-being. These ideas are frequently crude, and oftentimes totally fallacious, but, in the absence of more enlightened views, they form a code whereby the individual would, (even if through carelessness or the gratification of appetite he does not,) govern himself. Looking back through the most authentic records, to the earliest history of the human race, this one idea of prolonging life is associated with every period of man's existence. And it further appears, that from the most primeval times, the idea has not been left to be decided and acted upon by every individual for himself, but that with the first and rudest forms of government and of law, there have been associated imperative precepts and commandments concerning the preservation of health. It is remarked by the Massachusetts committee, in their very able report, that "The sanitary movement goes back to great antiquity,

and is traced up to the direct revelation of the Supreme Law-Giver. "In the day that thou eatest thereof, thou shalt surely die," may be regarded as the first sanitary as well as moral precept. And from that time, down through the patriarchal ages, there is evidence that the preservation of health was inculcated as one of the primitive duties." The laws propounded by the prophet-legislator, Moses, for the preservation of the health of his people, may be cited as an evidence of the antiquity of the subject, as well as the rare sagacity of that great and wise man. The full details of these laws and regulations may be found in the book of Leviticus, and are well worthy a careful perusal. It is more than probable, however, that the idea of incorporating hygienic laws with religious belief, dates anterior to the time of Moses, and was suggested to him by the knowledge that the first sovereigns of Egypt instituted similar observances. The example set by Moses was followed by the founders of the Greek cities, and furnished to them the basis for their sanitary laws, to which additions and improvements were made. Chief among these were the bath and gymnasium, the latter of which produced the finest athletes of that or any succeeding age. It is an interesting page of history, which recounts the practices of the Greeks, for the purpose of producing, physically, an iron race of men. Not the least wonderful part of it all is, the acumen and wisdom displayed in some of their health regulations. It is sufficient to say that many of these were elaborated by such men as Lycurgus, Hippocrates, Plato and Aristotle, and in correctness have scarcely been surpassed to this day. In Sparta, so fixed was the policy of rearing only robust and vigorous men, that it was an affair of the State, to which all parental feelings of tenderness and love were compelled to yield.

The object had in view by the Grecians in thus creating a hardy race, had reference, however, more to building up the power of the country as a great and conquering nation, than to promoting the happiness of the people.

With the Romans, the purpose, while partaking in a measure of the same idea of war and conquest, was largely composed of better motives; motives looking to the building up

of a people who should rule the world, not only by the force of arms, but by the power of a superior intellect. *Mens sana in corpore sano*, was an early maxim with them, and the effort was made to accomplish the ideal expressed in it. "But the Romans were the most sagacious and extensive legislators in such matters. They were in many things masters of the practical; and have left vestiges still pregnant with the wisdom of experience. With them, nothing seems to have been deemed 'common or unclean' that could protect the public health. We find Pliny writing to Trajan about a fetid stream passing through Amastris, as if it were an affair of State. The Cloacæ of the Tarquins are still among the architectural wonders of the world. The censors, ediles and curators who at different periods had charge of the buildings and the apparatus for the removal of impurities, were invested with great powers for the execution of their functions, and derived a corresponding dignity from them. The arrangements for supplying the houses of Rome with water were most minute. Those for ventilation and drainage, still traceable in the several remains of Roman amphitheatres, have struck our most advanced sanitarians with surprise at their remarkable adaptation to their purpose; while Mr. Chadwick tells the commissioners of sewers that he has lately received from a friend in Zurich a specimen of exactly such an earthenware pipe as he is now recommending for the distribution of sewage. It had been laid down by the Romans, and has worked, until recent times, under 500 feet of pressure. Indeed, it is easy to see from Vitruvius, and from portions of the collection of Grævius, that the rules and operations for the protection of health in Rome were of a very radical and peremptory character, and allowed no minor interests to interfere with them. It seems to have been a rule with them, that from the time when the foundation of a city was laid, to that of the summit of its greatness, no structural operation, public or private, should be permitted to take a shape, which might render it a harbor either for disease or crime; and it is to this vigilant forethought that, in the absence of other organizing agencies discovered only in our later times, we may attribute the success with which that remarkable people preserved social or-

der throughout so dense and vast a mass of human beings as the inhabitants of the Imperial City in the days of its greatness."*

When the light of this great nation was extinguished by the incursions of the barbarians, there ensued a period which has been aptly termed by historians, the dark ages; during which the world was plunged into the depths of ignorance and superstition for nearly seven hundred years. Were it possible to have compiled statistics, showing the mean duration of life under a state of existence when the human race partook of the nature of the savage, and lived according to the dictates of the lowest intelligence and most debased moral perception, such a compilation, when presented in contrast with the mental and physical condition of man during the nineteenth century, would be the most perfect and conclusive argument that could be adduced in favor of an enlightened and scientific regulation of life.

In the fourteenth century, John II., of France, instituted the first sanitary regulations, which have been regarded as the commencement of a sanitary reform. These regulations were of a very crude character, but served to give the impetus which carried the movement in a few centuries to a great degree of perfection, and at length culminated in the admirable system presented at this time by certain of the European governments. France now enjoys, though a very complicated, a very efficient system of sanitary police. Great Britain, though only aroused fully to the importance of the subject within the last forty years, has largely reduced the mortality of the country by wise and stringent sanitary regulations. In the German and Prussian States, systems of sanitary and medical police have been fabricated and put into operation, probably more perfect in their details and more salutary in their results, than in any other portion of the world.

In our own country, the sanitary movement is as yet in its infancy. During the past twenty years, however, eminent medical men have constantly agitated the question of a sanitary reform, which, founded upon the basis of our present

* Edinburgh Review, January, 1850; quoted by Shattuck.

knowledge, shall develop itself into a code insuring to each community the maximum of life, health and vigor compatible with the Almighty fiat.

An important movement of this kind was projected by the American Medical Association in 1849, through which sanitary sketches of a number of the larger cities of the Union were received; these sketches being published by that body as a valuable contribution to the subject. In 1850, growing out of the new direction given to the current by these and other movements, Massachusetts, ever foremost in the investigation and adoption of measures promotive of the intelligence, health and happiness of her people, appointed, by legislative authority, a sanitary commission, "to prepare and report to the next General Court a plan for a sanitary survey of the State, embracing a statement of such facts and suggestions as they may think proper to illustrate the subject." This commission, composed of Lemuel Shattuck, Nath. P. Banks, Jr., and Jehiel Abbott, discharged the important duty entrusted to them, and compiled a report which has become a standard contribution to the literature of the subject, and which should have a place in every public and private library in the country. This action upon the part of Massachusetts is, perhaps, the only State executive attempt as yet made in our country looking to the establishment of a systematized code of sanitary laws, enforced by the strong arm of executive authority.

That there should have been no organized effort for the systematic promotion of public and private health as yet in our country, is, perhaps, fully accounted for by our form of government. All power coming from the people, and supposed to reflect but the will and sentiment of the people, there can be no movement so restrictive and imperative in its operations, put into thorough practice until the people themselves shall see the necessity of it, and at least acquiesce in, if not demand it. The same question has been tested in various ways, and has uniformly failed, because the masses have not been convinced of the necessity or propriety of the measure proposed. At the meeting of the American Medical Association, in 1863, a committee was appointed by that body

to prepare a memorial to Congress, praying for the passage of a law rendering it imperative for every man, woman and child in the country to be periodically vaccinated. One would suppose that having witnessed the benefits of vaccination as a protective against the ravages of that dread disease, small-pox, for the last forty years, the world would be ready to acquiesce in any measure that would make its adoption universal. But the committee reported that the passage of such a law, so far as they could learn, would be premature and in a great measure useless, because the people, in mass, were not educated up to the necessity of the measure. The committee were then empowered to prepare and circulate such documents as would pave the way for a general acquiescence upon the part of the people; after which, it was hoped, such a law might be made operative.

As illustrative of the necessity of a perfected code of sanitary laws, no more striking example than this could be adduced. Before the discovery of vaccination by Jenner, small-pox, directly and indirectly, filled more graves than any other single cause, or, perhaps, than any other half dozen causes known to man. It was "as the pestilence which walketh by noon-day," striking down at least one-half of every community which it entered, and carrying off to a loathesome grave one out of every four it attacked; to say nothing of those who, having resisted the immediate onslaught, subsequently succumbed to its dread power through the long line of other diseases, which it nurtures and calls into life. Since the discovery, however, that the vaccine disease prevents the establishment of small-pox in an immensely large majority of cases, and that the mortality is reduced to a very small ratio in those who are attacked, after having been subject to vaccination, small-pox is a disease which no longer assumes the terror of a plague, nor counts its yearly victims by millions. Vaccination is, therefore, a sanitary measure of the greatest importance, more particularly as it is thought by men of extensive experience, that through the efficient and universal practice of vaccination and re-vaccination, that once dreaded scourge would disappear from the face of the earth. Truly, no more sublime spectacle could be presented than that which shows

us the triumph of man's intellect in vanquishing the elements of a fallen nature, and in lifting himself to that pinnacle which proclaims him as being formed after the likeness of his Maker, and the master-type of His handiwork.

While such miraculous results have followed the discovered prevention of small-pox, others not so specific, yet no less striking, have followed as the consequence of a strict observance of those measures preventive of the influences out of which disease is nurtured and death is born into the world.

As an illustration of the fact which is here designed to be represented, may be cited the example of the city of Geneva, in Switzerland. Here an accurate record of the population, births and deaths has been kept for more than three centuries past, or since the year 1560. By a series of historical and statistical compilations, M. Mallet has ascertained that from the year 1560 to the year 1600, the mean duration of the lives of the people was, in round numbers, twenty-one years and two months. During the seventeenth century, the mean life had increased to twenty-five years and nine months, and in 1833 it had reached forty-five years and five months, being nearly double what it was about two centuries before. This result was brought about by a most salutary regulation of the public health, through which much of the former unnecessary sickness was prevented.

THE UNIVERSAL IMPORTANCE OF THE SUBJECT.

This is a striking instance of what may be done, as a preventive of disease, and to lengthen out the term of life; or, more properly, to insure to each individual the full quota of years allotted to him by the Almighty decree. The records of sanitary science abound with the most surprising examples of the unnecessary destruction of human life in the attempt to live. The aggregate of lives lost by the engines of war each year, and by all other causes of violence combined, presents but a trifling mortality beside the sum total of those sacrificed at the shrine of the ubiquitous monarch, Disease.

"In England alone, the average annual number of deaths from disease is, in round numbers, 300,000; while that of deaths from the mere decay and exhaustion of the human

frame by the progress of time, is 35,000. In the difference between these two numbers, we see the vast and vital field in which the sanitary reformer proposes to work. That disease shall ever be entirely exterminated, is, of course, beyond the belief or hope of the most sanguine. *But every disease has, somewhere, its specific and efficient cause, and that these causes can be removed, or much weakened in their action, in very many instances, is not only within the bounds of hope, but has been satisfactorily proved.*

"When sanitary legislation gives us its successful results, they will be represented by the reduction of the number of those who die of disease in their early days or in the prime of life—and in the increased number of those who have completed their allotted course in health, and been peacefully gathered to their fathers. Accordingly, sanitary improvements have not directly in view the extension of the natural period of human life, but only the removal of influences which artificially curtail it."*

Some forty years ago the people of Great Britain were startled into the realization of an excessive mortality bill, made all the more appalling by the conviction that, to a great extent, it was entirely unnecessary. At varying intervals the attention of the authorities was called to the matter by committees from the House of Commons, and by various scientific documents, emanating from persons of high standing. Commissions of investigation were appointed from time to time, and efforts at reform were made. These, like all great works, were necessarily slow, and but partial in their results. The following extracts, gleaned from various sources and quoted by Shattuck, will prove interesting, not only in a historical sense, but also as laying bare a condition which, to some extent, exists in our own country; and which paints in strong colors the evils of an attempt to rear a healthy, happy, and prosperous population through an utter disregard of nature's laws:

"By a statement drawn up by Dr. Guy, Physician to King's College Hospital, from the reports of the Registrar-General,

*Edinburgh Review for January, 1850; quoted by Shattuck.

it appears that the relative mortality in the town and country districts was as follows:

	Country Dist.	Town Dist.
Population to the square mile,	199.	5,100.
Annual deaths in 1,000,000,	19.300	27.073.
Rate of mortality,	1 in 52.	1 in 37

"The influence of the purer air of the country, and the better hygienic condition generally, of those residing therein, is here shown with much force. Out of the same number of people, the one compressed within a town district into a space at the rate of 5,100 to the square mile, while the advantages of the same space are enjoyed by the other at the rate of 199 only to the square mile, there is a difference in the mortality in favor of the latter, or those reaping the advantages of freer circulation of air of 7,773 souls."

"The following was Dr. Guy's statement of diseases which occasion the excessive mortality in large towns:

	No. of deaths in 1,000,000 in Town.	Country.
By small-pox,	1,000	500
By measles,	900	350
By scarlet fever,	1,000	600
By typhus fever,	1,250	1,050
By epidemic and contagious disease,	6,900	3,400
By infantile diseases—teething, convulsions, water in the head—	3,500	1,300
By scrofulous diseases and consumption,	4,600	3,800

"Total excess of 5,500 in the 1,000,000. So that there is a waste of 22,000 lives in the 4,000,000 inhabiting large towns."

"Further still, Dr. Lyon Playfair calculates that for one unnecessary death, there are twenty-eight cases of unnecessary sickness; consequently, in our large towns, above 700,000 cases of unnecessary sickness. The same calculations in the metropolis would save 10,000 deaths and 250,000 cases of unnecessary sickness."

"Then it may be asked whether all parts of our large towns are equally subjected to these causes of sickness and death? So far from that being the case, I find, from one of the reports of the Registrar-General, that the metropolis is divided into three groups, of ten districts each, under the title of *the*

healthiest, the medium, and *the most unhealthy districts.* The result is as follows: 10 healthiest, with an allowance of 202 square yards to each person, have a mortality of 1 in 49; 10 medium, with an allowance of 102 square yards to each person, have a mortality of 1 in 41; 10 unhealthiest, with an allowance of 32 square yards to each person, have a mortality of 1 in 36."

"But it would be impossible here to give even an analysis of these documents and works. The following are among the many conclusions to which we are led from the information they contain:

"1st. *It is proved,* that there die annually, in each 100 of the population of the whole of England, 2.27;—of the most healthy district, 1.53, and of the most unhealthy district, 3.58; and that the living to one death are in these districts, respectively, 44, 65 and 27.

"2d. *It is proved,* that the various forms of epidemic, contagious and other diseases, caused, or aggravated, or propagated by atmospheric impurities produced by decomposing animal or vegetable substances, by damp and filth, and close and over-crowded dwellings, prevail amongst the population in every part of the kingdom, whether dwelling in separate houses, in rural villages, in small towns, or in the large towns, as they have been found to prevail in the lowest districts of the metropolis.

"3d. *It is proved,* that disease and mortality fall more heavily upon those who live in large towns and populous places, than in the country districts, and particularly upon those who live in narrow streets, confined courts, damp dwellings, close chambers, cellars undrained, unventilated and uncleaned; and affect most severely the infantile portion of the population, and the heads of families between twenty and thirty years of age.

"4th. *It is proved,* that, in such situations, the average duration of life is five to twenty-five years less than it otherwise might be; and that during this curtailed period of existence the working power of those who live, and their capacity for enjoyment, are greatly diminished by a constant depression

of health and spirits, and by the active attacks of fever, cholera, scrofula and consumption.

"5th. *It is proved*, that such diseases, wherever their attacks are frequent, are always found in connection with the physical circumstances above specified; and that, where these circumstances are removed by drainage, proper cleansing, better ventilation, and other means of diminishing atmospheric impurity, the frequency and intensity of such diseases are abated; and where the removal of the noxious agencies, and other causes of disease appears to be complete, such diseases almost entirely disappear.

"6th. *It is proved*, that the annual mortality might be reduced in the whole kingdom from 2.27 per cent., or 1 in 44, to less than 2 per cent., or 1 in 50; and, in all large towns, as low as that general average.

"7th. *It is proved*, that this unnecessary excess of mortality above 2 per cent., occasions an annual loss of more than 50,000 in the United Kingdom,—'greater than the loss from death or wounds in any wars in which the country has been engaged in modern times;' and that the causes of these unnecessary deaths occasion at least twenty cases of unnecessary sickness, on the average, to each death, or 1,000,000 cases annually, which might have been prevented.

"8th. *It is proved*, that of the 43,000 cases of widowhood, and 112,000 cases of destitute orphanage, relieved from the poor rates of England and Wales alone, the greater proportion of deaths of the heads of families, occurred from specified removable causes; and that the average of their ages was under forty-five years, or thirteen years below the natural probability of life, as shown by experience.

"9th. *It is proved*, that the preventible causes of disease, and the unnecessary mortality, impose upon the people immense pecuniary burdens, which might be avoided.

"10th. *It is proved*, that the younger population, bred up under noxious physical agencies, is inferior in physical organization and general health to a population preserved from such agencies; and that these adverse circumstances tend to produce an adult population, short-lived, improvident, reckless,

intemperate, immoral, and with excessive desires for sensual gratifications."

In further illustration of the startling truths which are here presented, may be adduced the following quotations by Shattuck.

The British and Foreign Medico-Cherurgical Review, Vol. II., for October, 1848, in an elaborate article, after giving a tabular statement of the relative mortality of the Bolton Union, sums up in the following words: "Thus the mortality of Great Bolton is greater than that of Sheffield, which hitherto enjoyed a bad eminence in this respect; and out of the population of about 36,000, *near six hundred*, or 1 in 60, die unnecessarily each year. What should we think of an annual sacrifice of one out of every sixty of our population, to satisfy the cravings of some insatiable monster like the Minotaur of old? Should we not put forth every effort, and be ready to sacrifice all our worldly possessions, to avert it? And yet this sacrifice is, in effect, offered up every year in Great Bolton to the Ogre, *Filth*. The fact is too plain to be gainsaid."

The same journal, in an article on "Cholera and Sanitary Reform," Vol. 4, Jan., 1850, uses the following vivid words: "Let us endeavor to realize this astonishing fact. A disease has lately crossed over these countries, which, in our metropolis alone, has swept away 15,000 souls. We have lost in all Britain more lives than we have lost in battle since the days of Marlborough. And looking at the matter in a more worldly sense, who can know the incalculable value of many of these lives? Every man instinctively pictures to himself how much misery, and lasting grief and sorrow this great mortality symbolizes. It requires no stretch of imagination to realize a great national calamity, of which the actual deaths are but the smaller items. Behind each death we can trace easily the anguish of the living; the distress of those left fatherless, husbandless, childless; the hopes blighted; the ties broken; the companionship and sympathy forever destroyed. A thousand mental pangs, and among the poor, a thousand bodily hardships are the legacies and sad memorials of every death. Callous and cold-hearted indeed must he be who can

turn aside from such a record, without seeking to probe this national wound, and to demand whether there is no healing force whereby its bleeding surface may be staunched. In the midst of the general distress, a set of men come forward to say that they have found a plan for preventing the recurrence of this frightful slaughter. These men are no enthusiasts, but are the persons of all others, by education and experience, best able to know the truth of their assertions. The whole medical profession announce that they can prevent, if the means are given them, the recurrence of this mortality and suffering. Are these men worthy of credit, or are they not? If they are, then where is the government, where is the nation, that can disregard this assertion—that can blindly shut its ears to those groans of anguish, the echo of which has not yet died from our affrighted air—and careless of the future, can see with indifference the inevitable recurrence of that fearful drama, which, in a few short years, must be again repeated?"

Could appeal be more eloquent than this? Could facts be more forcibly put, or more incontrovertibly maintained?

But the same voice of warning ascends from our own soil, our own physicians: "In 1842, the Hon. Horace Mann, as Secretary of the Massachusetts Board of Education, propounded to several physicians the following question: 'How great a proportion of disease, of suffering, of usefulness and of abridgement of life comes from sheer ignorance, and which we therefore might hope to see averted, if the community had that degree of knowledge which is easily attained by all?' To this question, Dr. Jas. Jackson, of Boston, replies: 'I feel assured that the answer should be, *more than one-half*. When it is brought to mind that the ignorance of parents is included in the terms of the inquiry, the justice of the answer will probably be admitted by all who are conversant with the subject.' Dr. S. B. Woodward, late Superintendent of the State Lunatic Hospital, says: 'I have no doubt that *half* of the evils of life, and *half* the deaths that occur among mankind, arise from sheer ignorance of the laws of health; and that a thorough knowledge of these laws would diminish the suffering incident to our present state of being, in very nearly

the same proportion.' Dr. Edward Jarvis replies: 'From an observation of thirteen years, I have been led to believe that *three-fourths, perhaps more,* of the ailments of men come from a want of sufficient knowledge of their frame, or a disregard for it.'"

Such statements, coming from sources so reliable and trustworthy, cannot be disregarded or made light of; and the conclusion to be adduced therefrom is inevitable—that *fully one-half of those who die at the present day, do so prematurely, and through causes which it is in the power of man himself to prevent.* The instance of the city of Geneva, before cited, whereby the average term of life has been doubled in two centuries through the agency of those very means which it is the object of this report to urge upon the attention of the people of Kansas, is but a solitary example of the beneficial results flowing from the measures proposed. These pages could be filled to undue length with illustrations of the improved condition of health under proper hygienic arrangements; illustrations from the country, the town, the city; the public charity; the penitentiary; from armies and navies, and all sorts of places and institutions where man is found and makes the effort to live.

The following quotation is from Dr. Shattuck's Massachusetts report, and is here given, not only as the sentiment of the writer of this report upon the subject, but as expressing, in a few words fitly chosen, the settled conviction of those who have given it serious consideration:

"*We believe the conditions of perfect health, either public or personal, are seldom or never attained, though attainable; that the average length of human life may be very much extended, and its physical power greatly augmented; that in every year, within this Commonwealth, thousands of lives are lost which might have been saved; that tens of thousands of cases of sickness occur which might have been prevented; that a vast amount of unnecessarily impaired health and physical debility exists among those not actually confined by sickness; that these preventible evils require an enormous expenditure and loss of money, and impose upon the people unnumbered and immeasurable calamities, pecuniary, social, physical, mental and*

moral, which might be avoided; that means exist within our reach for their mitigation or removal; and that measures for prevention will effect infinitely more than remedies for the cure of disease."

THE SUBJECT AS APPLIED TO KANSAS.

What has now been said is a mere outline of the results which have been developed within the past fifty years, in relation to the life and health of man. Did the occasion permit of detail, statistics could be furnished, so convincing that the truth of what is here endeavored to be pictured, would be made patent to all.

The State of Kansas, considered in reference to its age, is as yet in its very infancy. That density of population belonging to older States, which is so destructive to life and health, is an evil as yet not entailed upon it, though year by year great additions are being made, and it is apparent that in due time the State will be a most thickly populated one. In its present elemental condition, it were far easier to give proper shape and direction to its domestic and social institutions than after the lapse of years, when cities have been built, public works erected, and individual rights have been acquired. Thus far, absolutely nothing has been done looking toward securing to the people of the State the enjoyment of health, with all its attendant blessings. No law has been passed, (with the single exception of a registration law last winter, and which thus far has been a dead letter,) or officers appointed, to give to the inhabitants that which is of more importance to them than all other laws upon the statute books.

This is as much due, perhaps, to the fact that public attention has not been called to the necessities for such legislation, nor the public mind enlightened upon the laws of life, as to any existing recklessness or disregard for health.

A painful example of the lack of any health-considering laws, exists in Leavenworth, the largest city of the State. Located naturally upon a most eligible situation for salubrity, there existed, until recently, a general surface pitch, which, by the intelligent and skilful adjunct of art, could have been converted into a simple system of drainage of the most per-

fect and efficient kind, and projected at a wonderfully small expense. Through a mistaken official policy, the advantages given by nature to this favored situation, have been greatly perverted. Streets have been made to pitch within a few squares in as many different ways, while others have been reduced to a dead level. Thus the opportunities for a uniform system of drainage have been much lessened, save by a radical change of grade, and it is safe to say that the health of the city suffers to a greater extent than it otherwise would through the agency of miasma, generated from the stagnant puddles with their decomposing remains, which are to be found in many parts of the city proper.

In illustrating the necessity for stringent sanitary laws in our State, it will be necessary thus to refer, at times, to local conditions in connection with the more important towns; for, as will elsewhere appear, (see sanitary sketch of the State,) the topographical features of the State at large warrant the assumption that it now possesses a high degree of salubrity, which, under the proper management, may be greatly augmented; and, therefore, it is particularly in the larger towns that the blessings bestowed by nature are apt to be perverted, and an unnecessary mortality entailed. And, further, as in accomplishing the purposes of truth, candor of statement and fairness of criticism are of the first importance, in the pages of this report an impartial freedom of language has been adopted, and there has been no hesitation in characterizing evils where they exist, in the proper terms.

Happily for the people of Kansas, as before remarked, the newness of the State has prevented that accumulated flood of numbers, which builds great cities and makes them the catacombs of their inhabitants. As yet there are no narrow courts and alleys, with their thousands of poverty-stricken inmates, breathing an air laden with the exhalations from innumerable sources of filth; as yet no tenement houses, with their hundreds of miserable occupants, dragging out a sickly existence above ground, and in dark, mephitic vapors below.

But while all this and much more may be said in favor of the State, there exists, even now, a condition of things in some of the larger towns, highly prejudicial to public health,

and which is growing in extent year by year, in a direct ratio with the size of each town. Perhaps this remark is more applicable to Leavenworth than to any other of the young cities of Kansas, being probably three or four times as large as any of her sisters. In the case of Leavenworth, there is this great disadvantage, that being in a transition stage between a large sized town and a flourishing city, she possesses many of the elements of the insalubrity of a city, with but few of the requisites to counteract them. The lack of pecuniary means for rapid and stable improvements, and a deficient supply of water, are here more particularly alluded to.

A few of those general measures, which are necessary to be adopted by all cities aspiring to the enjoyment of even a fair percentage of health, will now be briefly considered and conclude this portion of the subject.

Drainage.—To insure any prospect of healthfulness in a city, one of the first essentials is a thorough and complete system of house and street drainage. To procure such a system, it is suicidal to wait until a town shall have grown to the proportions of a city before establishing the grades of the streets, and then only as has been done in Leavenworth, to establish the grade of each street as it is opened up for occupancy. Every village, with any prospect of becoming large enough to disturb the natural site, should be surveyed by a competent engineer; a general plan of drainage should be established; a public map should be drawn, with the elevations of the street-crossings, and their descent to their outlets marked down. After such a plan had once been established it should be rigidly enforced under every authority, no change of political administration or pandering to private interests being allowed to interfere with it. Thus every individual would have a guide in erecting his building, and be enabled to make provision for his house drains, while the city itself would be put in the most favorable condition to construct all necessary sewers, &c., in the simplest and most economical manner.

The drainage of cities is accomplished by the means either of *surface drains* or *underground sewers*. The former, for some localities, answer a tolerably good purpose, but, as a

general thing, are not to be compared with a well-devised plan of underground sewerage, for the reason that half-fluid mould, stagnant water and various sorts of filth are almost sure to collect in places, and poison the air with their emanations.

The idea of underground sewers had its origin at a very early period, and those constructed by the Romans, the remains of which are still to be found, were of immense proportions. In all of the large cities of Europe and America, they are now relied upon, almost entirely, for the purposes of drainage, and for carrying off the putrefactive debris of a crowded population.

When their functions are confined to liquid excreta, there can be no two opinions as to their utility, provided they are properly constructed as to their architecture, their descent and their outfall. The modern world, with its innovating propensities, has, however, enlarged their uses; and it is now common to find, in all large cities in England and America, (though the Continental cities have not yet generally adopted the practice,) direct communications, from all the upper and even middling class of houses with the sewers, through which the contents of the water-closet, the kitchen, and every sort of house refuse are discharged into them. This semi-solid mass accumulates in the sewers, and there is no agency by which it can be thoroughly removed, except the labor of the hands. The pestiferous gases which arise from the putrefaction of these remains, diffuse themselves through the air and destroy its purity, inciting to, if not absolutely provoking epidemic visitations; at all events, greatly lowering the health-rate in the vicinity.

These, with other considerations, render still a mooted point the most effectual and least deleterious means of carrying away the immense amount of excreta discharged by the daily life of a large city; but there can be no doubt that the sewer, when confined to its legitimate office of conveying only liquid refuse, is at present the most available method of getting rid of a large portion of it, as well as of draining away the surplus water.

Each city, then, should have a well devised system of sewerage marked out to correspond with the established grade.

In this manner, the grade of the whole city having been arranged as to shed the water in a few general directions, the main sewers could be constructed as the city became ab and the accessory sewers of smaller dimensions afterwar This would be the ideal of a city drained upon the most pe fect principles of expediency and economy. It is entirel practicable for all of our new States to possess themselves such a system. The older cities of the Union and of t world have realized the fact here stated, only after they h acquired a dense population, and with them it was cons quently impracticable; but profiting by their experienc there is no reason why every new city that is hereafter become a metropolis, should not, by a wise and comprehensi course of action, enjoy a system of drainage fully correspon ing to the knowledge of the times.

Let the young cities of Kansas consider well this matte But one of them, as yet, has extensively disturbed its natura site. The one alluded to, as before intimated, has heretofor pursued, to some degree, a suicidal course. Much of th grading has been done from street to street, and in some i stances, it is believed, has been made to conform to privat interests. The legitimate results of this must inevitably b that to establish a thorough drainage hereafter, the city wi be put to an expense difficult to estimate, in order to construc the greatly increased number of sewers, necessitated by th irregularity of grade.

Before leaving the subject of sewers, it may not be amis to state a few general facts relative to their construction. Th whole subject of sewerage is so replete with practical detai that a small volume could be written upon it. It will answe the purposes of this report to say that their *dimensions*, thei *descent* and their *outfall* should receive particular attention.

They should be amply *large* to enable them to carry of any amount of fluid which might, in any possible contingency be poured into them. Their *descent* should be sufficientl great to convey the stream in as rapid a manner as possible Thus a greater amount of solid material could be carried of than if the current were sluggish, allowing the solid portion

to be deposited, filling up the bottoms of the sewer, and emitting noxious gases when undergoing putrefaction.

The *outfall* of a sewer requires attention in its construction. In those localities where the sewers empty their contents into a tidal river, the subject is of more importance, perhaps, than in other cases. When the tide recedes, the filth poured out is left to pollute the air in the vicinity until the rising tide again covers it up. But in either case, the matter is one of much moment. The extremity of the sewer should be so arranged that the river could not back it up and arrest its flow, nor should the vent be situated so far above the water that a portion of the contents of the sewer would be left upon the ground to putrefy under a reeking sun. Perhaps a good plan would be to allow the level of the sewer to be above the water-surface, and then, when sufficiently near the margin, to cause it to bend down at a right angle, which latter might be reflected obliquely off from the right line, thus discharging the contents into the stream, in a direction *with* the current.

Paving.—Closely related to the subject of sewers is that of paving. If sewers are important as a means to carry off surplus fluids, pavements are equally important, that the fluids may be carried into them. A good pavement, such an one as will fully answer its purposes, is expensive, and as a consequence, young cities just beginning to adopt a system of street paving, seek that which is cheapest. The first effort usually consists in *plank sidewalks* and *macadamized* streets. This is the only plan as yet generally adopted in Kansas. It is not a good one for the public health. The plank sidewalks not only allow a complete passage of all fluids through them, so that the subsoil, if a retentive one, is kept filled with moisture, giving out deleterious vapors, but they likewise add to these the products of the decaying wood. Upon the same principle, the macadam is a poor paving for the street. It is so porous that the water, instead of flowing off by the gutters, percolates into the earth, which, being protected from the drying influence of the sun, remains in a wet state and renders damp and unwholesome the adjoining cellars. Within the past year, quite an improvement has been made in the con-

struction of gutters in Leavenworth. This consists in a
high curb, with a wide flag of limestone for the gutter,
ly joined to its fellow. If the joints were cemented, no
could be better than this. The water that finds its way
the gutter flows off with a rapid current; but little of it
colates into the ground, and none remains in pits or ho
to be evaporated by the sun.

In concluding these few general remarks on the import
of a well-regulated system of drainage to every city, it
not be inappropriate to quote some paragraphs from a "
port on the importance and economy of sanitary measur
cities," by Dr. John Bell: "Your reporter will content h
self with introducing at this time some statements taken
a mass of evidence which he had previously collecte
other purposes. To begin with *paving*, it might be suffi
to say that the evils from neglect of it are pointed ou
most of the reports on the health of towns, but we ca
forbear from again adverting to the effects witnessed in L
don. Before the streets of that metropolis were pa
inhabitants were as great sufferers from periodical feve
those of the worst situated rural districts in our own cou
and until underground drainage had been adopted to so
extent, dysentery was common and largely fatal. Draw
on home experience, it has been found that in Philadelph
the exemption of the inhabitants from intermittent and bil
remittent fevers has, with great uniformity, followed the p
ing of the streets. The space now called Dock street w
in the early days of the history of Philadelphia, a m
swamp, traversed by the sluggish stream Dock creek,
either side of which, periodical fevers of all grades prevai
with a violence equal to those met with in the most sic
districts in distant States. The exposed surface having b
paved, and the creek partly filled up and covered over a
made the line of a great culvert, no person residing th
now has any apprehension of fevers such as those t
afflicted the former dwellers there." * * * *

"One of the most remarkable examples of the benefi
change in the health of a city produced by paving its stre
is furnished in the history of Louisville, Kentucky, whi

being called the graveyard of the West, is now regarded
e of the most healthy cities of that extensive region.
mittent fever was, as we learn from Dr. L. P. Yandell, a
ar annual visitor, and occasionally a form of bilious fever
iled, rivalling yellow fever in malignity, and threatening
populate the town. The citizens awakened, after the
of 1822, to a sense of their condition, and to the means
ending it, set about a system of improvement, the chief
re of which was paving of the streets, and filling up the
s. The change in the sanitary character is the more no-
ble, as it was brought about without the aid of subsoil
age by sewers."

ntilation.—No discourse upon the best means of preserv-
ealth would be complete, did it not dwell with emphasis
ventilation.

e great scavenger of the human system is the principle
d oxygen. This gas existing in proper quantity in pure
spheric air, is taken into the lungs at each inspiration,
being there brought into contact with the blood loaded
the effete or carbonaceous matters of the system, pro-
a result in the animal economy that is no less wonder-
han necessary. A certain quantity of the oxygen of the
ed air combines with the waste material of the blood,
being *expired*, is given back to the atmosphere in a form
h unfits it for the further purpose of respiration. While
ir is pure, this function is performed with great regulari-
nd the well-being of the system is maintained. But if
ir be impure,—if that great pabulum without which we
d not exist for a moment, be habitually furnished in in-
ient quantities,—results ensue which sooner or later de-
the integrity of the various functions, and establish dis-
d action in the system. These facts, though sufficiently
t upon to be known by all, seem to be regarded by the
st number. The accountant, the seamstress, the artizan,
who are confined to a close room, breathing over and
again the same air, and who suffer, as a consequence,
headaches, and feelings of prostration and debility, never
consider that they suffer thus because they are violating

these districts, during the epidemics of 1853–4, there were distributed two different qualities of water; so that one population was drinking a tolerably good water, another large population an exceedingly foul water, while in all other respects these two populations (being intermixed in the same districts, and even in the same streets of these districts,) were living under precisely similar social and sanitary circumstances. And when, at the end of the epidemic period, the death-rates of these populations were compared, it was found that the cholera mortality in the houses supplied by the bad water had been *three and a half times as great* as in the houses supplied by the better water."

From this extract, it will be seen what a potent influence in subverting the normal functions is exerted by unwholesome water.

It is, however, a matter of some difficulty to obtain water in the requisite degree of purity, and particularly in new cities, where no effort has been made to supply the people from a common source. It may be stated, as a general proposition, that the waters of a navigable stream, particularly those whose banks are dotted with towns of all sizes, are not well adapted to drinking. The amount of effete matters, animal, vegetable and gaseous, which such streams hold in solution, is enormous, and though efforts are made at purification by water companies, they are but partially successful.

The question of pure water is one that has occupied the minds of men in all periods of the world, since they began to aggregate and dwell in masses. The immense aqueducts which supplied ancient Rome with an abundance of pure water, prove conclusively the importance attached to it, even at that early day. The larger cities of our own country have been, at different stages of their progress, compelled to solve, in some shape, this knotty question. Boston, with an enterprise and regard for her citizens which is truly commendable, stretches out her arms and brings the pure water of Lake Cochituate, a distance of twenty miles, into their houses. New York slakes her thirst with the Croton water, which is brought by a most costly structure a distance of forty miles. That young western giant, Chicago, keenly alive to the well-being

of her people, not only sent a commission to Europe to investigate the best methods for sewerage, but is now parting the waters of Lake Michigan with a view to supplying the city with water brought from the lake at a distance of two miles from the shore. The subject of pure water is just now occupying the attention of Cincinnati and St. Louis. Both derive their supply from the rivers on whose banks they are located. That the unnecessary waste of life in these cities from this cause is large, all having any experience in the matter will unhesitatingly admit.

The question is hardly a serious one in Kansas, as yet, her people deriving their supplies from springs, wells, cisterns, &c. But as large cities spring into existence, it will present itself in a very perplexing shape. The water of the Missouri river is no more potable than that of the Mississippi or Ohio. Whence, then, shall the cities upon its banks get their supply? Time, undoubtedly, will present a satisfactory solution to the question.

But even for those localities receiving all their water from wells or cisterns, it is still a matter for very grave reflection. If a well is sunk in the vicinity of a vault, or a sewer, its water may be poisoned by gases which infiltrate into it. Or if the well be a shallow one, or situated in proximity to manure piles, pig sties, &c., the surface drainage will be apt to contaminate the well, and render its water highly impure and unfit for human consumption. How often are our farmers and their families stricken with sickness, induced by drinking the water of a well sunk in a low place, and which is little more than the percolation from the surrounding ditches? These things, which affect our daily well-being so deeply, are but seldom thought of, and too little heeded even when brought to our attention.

The water from cisterns may be equally bad, if they are not properly constructed and filled. A good cistern should be walled up with brick or stone, and well cemented, and covered so as to be secure against the ingress of vermin; it should be located a safe distance from stables and vaults, and particularly out of the line of descent from them. It is well to have the cistern of sufficient dimensions to enable the fam-

shut off the water at a certain season. This season would be the beginning of spring. The cistern, being allowed to fill through the winter, at the earliest approach to spring weather, the water should be promptly turned off.

During the warm weather, the evaporation from sluggish streams and stagnant waters, fills the atmosphere with various organic matters both gaseous and solid. Amongst the latter may be mentioned the million forms of parasitic life, as algæ, confervæ, fungi, infusoria, &c., &c. These matters are washed down plentifully by the summer rains, and no expedient of filtering, however well devised, can insure fully against their ingress into the cistern. The experience of every observing physician teaches him that it is during the seasons when these conditions of the atmosphere exist to their fullest extent, that severe bowel complaints, manifesting themselves in the shape of dysentery, and even cholera itself, are most rife.

In view, then, of the general apprehension of an epidemic visitation from cholera the coming year, let every family in Kansas see that they are supplied with good, pure water to drink.

The foregoing remarks on the uses of water have been confined to the consideration of its potable qualities; its uses for purposes of cleanliness are also of the highest importance. For the farmer, or the small town, the well and cistern properly managed, will supply an abundance for both purposes; but for the large city, it is absolutely essential to be possessed of a prodigal supply. The bath, the wash, the flushing of sewers and drains, the cleaning of streets, the extinguishment of fires, &c., &c., all require an unlimited amount of this common but most invaluable article. That Kansas city which shall first supply a pure water for the drink of its people, and an abundance of it, for the purposes of their health and comfort, will outstrip all others in the race for greatness and prosperity.

Parks and Trees.—A measure greatly conducive not only to the general health of large communities, but to their happiness likewise, is the wise plan of supplying a city with parks or public squares. It has been said, not inaptly, that

they are the lungs of a city. It is here that the tired man of business, the man of toil, the valetudinarian, the house-tired female, the school-bound child, may all breathe the pure air of heaven, and bask for awhile beneath the cool shade of the trees. It is a most narrow policy which induces the founders of our cities to neglect this great adjunct to health, to comfort and to the beauty of a city. It is not too late for the cities of Kansas to make provision for a liberal number of parks. No investment will return to them with larger profits than money spent in this way.

THE DUTIES OF THE PEOPLE OF KANSAS IN RELATION TO THE SUBJECT.

As stated in the commencement of this report, it was no part of the design to enter into details. In order to illustrate, however, with force and clearness, the extensive field in which the sanitary reform works, it was necessary to depart so far as has been done from this design.

No State was ever situated more favorably than Kansas, to enjoy the largest share of vitality, of health, and of life, which it is possible to be reaped by man. Topographically and climatologically free from all causes which necessarily depreciate the normal health-rate, it needs but a wise, prudent and vigorous administration of public health-laws, to shape her embryotic institutions into a channel that will redound to the happiness and longevity of her people. There is this great advantage over older communities,—that they have learned the lessons which are now before us, through an experience purchased by the sacrifice of millions of lives, and after many of the evils were so fixed that it was impossible to remove them, save through the slow lapse of time and the expenditure of mines of wealth. It is far easier to build one's house to one's liking, than to alter it to his liking after it has been built.

Large cities are destined to spring into life within the boundaries of Kansas. Her beautiful prairies will ere long teem with a profusion of those staples which bring peace and plenty to an industrious population. The cabin of the pioneer will be exchanged for the comfortable dwellings and surround-

belonging to the successful farmer. The little town, with its one store and post office, where the lazy stage was wont to get a change of horses, and the hungry passengers a backwoods dinner, will resound to the din of the workman's hammer and forge, and the impatient champing of the iron-horse, as he stops for a moment to gather the stores which Kansas will ship from Galveston and San Francisco to the country beyond the seas.

When the tide of immigration which steadily flows in upon us, shall have built cities counting their population by thousands and tens of thousands; when great piles of brick and mortar loom up a barrier to God's fresh air, while weary men and women pant for its invigorating power below; when the conditions of life and health are so perverted that the allotted three score and ten is frightfully reduced; when public institutions are filled with the puny offspring of indigence and crime; when the filthy abodes of poverty and sloth shall warm into life a hundred pestilences to sweep off the bone and sinew of the State, then will the cry of alarm, which has startled the older communities of the world, find vent, and millions will be expended in the effort at a reform, which a wise and comprehensive legislation at this time might have rendered entirely unnecessary.

This picture is not fanciful or overdrawn; its counterpart may be found, to-day, in some of the great cities of the world. What an immense saving, then, of life, and in a sordid view, of money, might be accomplished if the builders of new States and cities, guided by those well-established laws of life which have been worked out at an appalling sacrifice to the human race, would erect the fabrics of their industry that they might redound to the happiness of their fellow-men.

In the olden time, before the laws which govern the economy of life were as well understood as they are now, the mortality of hospitals, prisons, military barracks, &c., was excessive. Placed under the most unfavorable hygienic conditions, the simplest ailments sometimes assumed the most serious forms, and filled an incalculable number of unnecessary graves. Under an enlightened comprehension of those laws, however, such institutions are now made to enjoy a fair

amount of the health resource, and the dreadful types which diseases were wont to assume in them, principally as a consequence of non-ventilation, uncleanliness, over-crowding, &c., are now almost entirely banished. Upon the same principle, it is entirely within the range of possibility to so build a city that the usual penalties attendant upon an aggregation of men shall be completely escaped. It is just as possible to build a *model* city as it is to build a *model* hospital, or a *model* dwelling-house; it is but a difference of extent in plan.

An impartial analysis of these views will reveal to any mind that there is nothing in them bordering on the Utopian or enthusiastic. They are eminently plain and practical, and if rightly acted upon will build up a State which has never yet been surpassed for the general intelligence, the happiness, the vigor and the prosperity of its people.

In consummating so desirable an end, the first step belongs to the Executive of the State. A sanitary commission should be appointed, which commission should be charged with the duty of making a complete sanitary survey of the State. Such a survey should have for its prime object the ascertainment of the natural health-resource of the State at large and in detail, and the causes which depreciate it; with a view, of course, to their removal so far as practicable. In accomplishing this work, the general physical features of the State should first be carefully investigated, and then the inquiry could be perfected by a consideration of the various counties, towns and cities. The points sought to be settled might be classified as follows:

1. *Location.*—Boundaries of the county, and its situation in the State. Its proximity to the water-courses and hills of the State.

2. *Hydrography, or Drainage.*—Size and direction of the water-courses, and of the dividing ridges, or water-sheds. Extent of river bottom. Power and rapidity of streams, and danger and frequency of inundation. Quantity of marshy or springy soil. Artificial water-channels.

3. *Topography.*—Area and mean altitude of each county. Location and size of principal towns. General character of surface, with principal valleys and eminences. Nature and

extent of surface destitute of vegetation; tilled, covered with forest, or grass. Agricultural products; kinds of timber; effects of clearing and of drainage upon climate.

4. *Geology* of different counties. Position, dip, direction and extent of different formations, as determined by State Geologist. Character of soil and subsoil. Source and nature of water used for domestic purposes.

5. *Meteorology.*—Latitude and longitude. Statistics, so far as accessible, of barometric, thermometric and hygrometric states of the atmosphere, indicating the annual and monthly amount of rain, hail and snow. Statistics of wind, so far as accessible.

6. *Particular survey of each town* in the State, of more than 1,000 people. The location, surroundings and number of inhabitants. The general plan upon which the town is built. Streets wide and at right angles, or narrow and crooked. What is the probability of a uniform system of drainage? Where is the refuse of houses, stables, &c., kept, and how disposed of? How is the town supplied with water? What is the material of the houses; how constructed; are there any crowded neighborhoods; how many families in a house? &c. How are the school houses, churches, &c., built and ventilated? How are houses warmed—by fireplace or stove? Are there any hospitals, and how built? Are there any provisions for public parks? What public nuisances, in the shape of slaughter-houses, unwholesome manufactories, and the like, exist? &c., &c.

7. *Prevalent diseases* in each county and city, so far as can be learned. 1. The endemics, and epidemics to which the locality has been subject—how affected by race, age, temperament, avocation, circumfusa, ingesta and density of population? 2. Fevers. Intermittent and remittent—their frequency as compared with former years, and with other months of the same year. Typho-malarial fevers—small pox, measles, diptheria, scarlatina. 3. Other diseases.

8. *Mortuary Statistics.*—Owing to the newness of the State, but little could be accomplished in learning, with any accuracy, the death-rate of any particular locality; but the means for a beginning in this direction might be instituted at

once, which before long would furnish valuable information.

It is not presumed that the aims of the commission should be confined to the programme here laid down. While this would serve as a basis for action, perhaps, other useful data and information might be appropriately collated.

The materials collected should be embodied in a report by the commission and presented to the Executive with such recommendations for a complete code of sanitary laws as they might deem expedient, embracing prominently among other necessary things the effective taking of the census as often at least as once in ten years; *a law for the efficient registration of marriages, births and deaths;* a law requiring *the compulsory periodical vaccination of every man, woman and child in the State;* also, one forbidding peremptorily, intra-mural interments, or burials within the limits of towns and cities.

Profiting by the advanced state of the science of health in our day, a sanitary code could be perfected which would insure in the highest degree to the health, happiness and prosperity of our people. It is not pretended that, by any health regulations which would be likely to be adopted, humanity could be shorn of all its ills, disease be entirely conquered, and individuals die only of accident or old age. But it is proven beyond the possibility of successful contradiction, that if communities were compelled so to live as to avoid creating all of those unnecessary causes of disease which it is entirely within their power to prevent, the average term of life might be extended at least one-half its present duration, while the increased benefits to be derived from rearing a more vigorous, happy and intelligent people, are utterly beyond calculation. It has been the effort of this report to present the salient points of the subject, in as concise a manner possible, Though a mere sketch of a subject upon which volumes have been written, it is hoped that the strong features have been presented in such a light as will induce the Executive of the State to realize the importance of moving at once in a matter so closely interwoven with every material interest, and so nearly touching the happiness of every fireside in Kansas.

SANITARY SKETCH OF THE STATE OF KANSAS.

Boundaries.—The political boundaries of the State place it between the 94th and the 102d degrees of longitude west from Greenwich, and the 37th and 40th degrees of north latitude. It is situated in the Great Interior Valley of North America, and while possessing, to a certain extent, the general characteristic features of the great Valley, it enjoys that healthful modification which accrues to each locality, as it advances sufficiently near to the western boundary of the Valley, (the Rocky Mountains,) to reap the advantages of the greater elevation above its synclinal line, without losing the general characteristics of the Valley itself.

Aspect.—There are no mountain chains within the limits of the State of Kansas, but its face is diversified by a succession of gently undulating hills, stretching off into ridges and intervening valleys. There is a gradual ascent of the surface from its eastern boundary, which, indeed, marks the whole country west of the Mississippi river to the Rocky Mountains.

There is perhaps, no fixed direction for the eminences, though the general inclination may be said to be from northwest to south east, thus forming innumerable water tables, which shed their waters into the streams pursuing an easterly course to reach the Mississippi.

Hydrography.—The great hydrographical axis of the region west of the Mississisippi, so far north as the 50th degree of north latitude, is the Rocky mountains. The Missouri river, which traverses the eastern border of the State for nearly half its length; the Kansas, with its large feeders; the Big Blue, the Republican, the Solomon, the Saline and the Smoky Hill; and the Arkansas—which flows through a portion of the southwestern corner of the State—are the channels through which a considerable part of the waters of the eastern base of those mountains find an exit, at first into the Mississippi, and from thence into the Gulf of Mexico.

Though this great axis gives a general direction of the waters from west to east, yet there are innumerable smaller axes existing which give rise to streams of greater or less magnitude; these traverse the State in all directions, and

finally disembogue themselves into the principal channels. In Northern Kansas, such minor axes, (in common parlance called "divides,") so arrange themselves as to throw the water into streams which either meander to the south and empty into the Kansas, or to the east to find outlet in the Missouri. The latter, upon the whole, are much the smaller. In Southern Kansas the inclination of pitch is more distinctly from west to east, making divides which either throw the water to the north into the Kansas, or to the south, forming streams which either flow in an easterly direction to join the Missouri, as the Osage, or southeasternly to join the Arkansas, as the Verdigris and Neosho. Through the means of lesser divides again, the streams find accessions through multitudes of smaller ones. Thus the whole State is traversed by a network of water-courses, some larger, some smaller, but amply sufficient for every purpose.

The waters of the smaller streams are pure and potable, but those stretching out their head toward the mountains, as the Missouri and Kansas, bring down in their bosoms the *debris* of the long region of country traversed. The former river is marked for its turbidity, having received the name more expressive than polite, "Big Muddy."

The amount of matter, organic and inorganic, held in suspension by this remarkable river, is indeed enormous. Of the inorganic materials, the chief are alumina, or clay, (mostly blue and yellow,) and silicious and calcareous sand, very finely comminuted. These are derived from the formations over which it flows. From its remote sources in the Rocky mountains, it is said to flow over an inclined plane, the upper layers of which have but little compactness, and are, therefore easily disintegrated. These are, without doubt, in part a tertiary deposit, and in part cretaceous. The Yellowstone and Platte, tributaries to the Missouri, surcharged with much the same debres, assist in the density of its solid constituents. Laden with this immense amount of foreign material, not even the rapid current, (the fall of the river averaging, perhaps, one foot per mile,) prevents its constant deposition. Accordingly, on the subsidence of its waters,

the surface over which it has flowed is covered with a deposition of silt or sand, varying from a few to many inches.

Beside its inorganic constituents, the Missouri is laden with organic elements; of these, in addition to the vegetable remains swept along its bosom, there were found by Prof. Bailey, of the United States Military Academy, countless numbers of microscopic infusoria. In one specimen of water examined, there were detected twenty diferent species, all alive and active. Notwithstanding impurities, and those arising from the refuse of towns upon its banks, and of the different craft upon its surface, there is a traditionary impression that its water is healthy.

Though as before stated, nothing approaching a mountain elevation is to be found in the State, yet the elevations are sufficiently great to give it a fine "rolling" appearance. In consequence of this, the breadth of river bottom proper, within the State, is comparatively very limited. All of the streams flow within rather narrow beds, surmounted on either side by steep banks, generally varying in height according to the size of the stream.

Kansas is, in respect of its natural drainage, unsurpassed by any State in the Union, and equalled by few having the same amount of arable land. There is but little marshy or springy soil in the whole State; the surplus water coursing down to the natural conduits, leaves no opportunity for that saturation of the ground which is observable in some of the other States, and particularly the prairie States east of the Mississippi river. The effect of this upon the general salubrity will be mentioned further on.

Timber.—The timber of Kansas being mostly confined to the margins of the water-courses, it is proper to speak of it here.

The State is not heavily timbered naturally, but when it is considered that coal of the best quality underlies the most of the State, supplying all of the requirements for fuel, and that as prairie fires become less frequent, the timber increases rapidly year by year, it must be admitted that for the useful purposes of life, the State will not suffer from a deficiency.

It is an interesting question in sanitary science, as yet un-

determined fully, what are the relative differences in salubrity between two regions, situated in other respects alike, the one moderately timbered, and the other densely so. That trees fulfill an important office in the economy of life, is well known; that they modify climatic conditions, is also well known. This they do by modifying the temperature through their action as conductors of heat, by their absorbing and emitting surfaces, and by their chemical influence.

It is probable that experience will demonstrate that while the beautiful prairies of the State are disencumbered of that surplus of wood, requiring the labor of years to prepare land for the plow, and therefore stand ready to yield bountiful harvests at once, there is a sufficiency of timber in Kansas to fill all the requirements pertaining to the economic and physical uses of the forest.

The following is not a complete list of the trees and shrubs of the State, but it embraces, perhaps, the principal varieties:

TREES.

Black Jack Oak	*Quercus Nigra.*
White Oak	*Quercus Alba.*
Red Oak	*Quercus Rubra.*
Burr Oak	*Marcrocarpa.*
Black Oak	*Tinctoria.*
Water Oak	*Aquatica.*
White or American Elm	*Ulmus Americana.*
Red or Slippery Elm	*Ulmus Rubra.*
Black Walnut	*Juglans Nigra.*
White Walnut	*Juglans Cathartica.*
Cottonwood	*Populus Canadensis.*
Box Elder	*Negundo Aceroids.*
Hackberry	*Celtis Occidentalis.*
Honey Locust	*Gleditechia Triacanthos.*
Willow	*Salix.*
Shellbark Hickory	*Carya Squamosa.*
Pignut Hickory	*Carya Porcina.*
Pecannut Hickory	*Carya Olivæformis.*
Sycamore	*Platanus Occidentalis.*

White Ash.....*Fraxinus Americana.*
Sugar Maple.....*Acer Nigrum.*
Red Mulberry.....*Morus Rubra.*
Linden.....*Tilia Americana.*
Crab Apple.....*Malus Coronaria.*
Wild Cherry.....*Cerasus Serotina.*
Coffee Tree.....*Gynocladus Canadensis.*

SHRUBS AND VINES, (UNDERGROWTH.)

Elder.....*Sambucus Canadensis.*
Shoemake.....*Sumach*, several varieties.
Green Brier.....*Smilax Rotundifolia.*
Gooseberry.....*Ribes.*
Hazel.....*Carylus Americana.*
Pawpaw.....*Anona Triloba.*
Prickly Ash.....*Zanthoxylum Americana.*
Raspberry.....*Rubus Strigosus.*
Blackberry.....*Rubus Villosus.*
Prairie Rose.....*Rosa Setigera.*
Grape, (two or three varieties,).....*Vitis.*

Geology.—Reference is made to the exceedingly interesting report of Prof. Swallow, for the geological details of the different formations, with the character of the soils, &c. It will be found that these indicate rare conditions for general salubrity. The soil of Kansas, consisting of an argillaceous or clay basis, is so tempered by an admixture of silicious and calcareous sand as to make it light and porous, yet not sufficiently so to impair its capacity for retaining a due amount of moisture. This constitution not only renders it highly available for farming purposes, but prevents that long continued saturation of the ground, observed in soils composed in great part of clay. This peculiarity also renders the surface entirely free from those collections of water in puddles and ditches, ensuing during the rainy season in localities where the subsoil is so strong and stiff from its clayish nature as to retain the water and prevent its drainage, leaving its removal to be accomplished through the process of evaporation. Hence, the soil of Kansas is not only adapted to large yields of every farming product requiring a light, rich and warm

soil, but it is better adapted to withstand the effects of dry seasons than the clay soils before referred to. The clay soil, during a protracted drought, bakes to a strong hardness, and kills vegetation, whereas, the light, pulverulent soil of Kansas permits the vegetation to strike root deeper into the soil, and imbibe moisture through the increased facilities for capillary attraction.

These remarks are made, as having a very close relationship to the subject of health, through the modifications of the atmosphere resulting therefrom. The influence exerted upon the general health by this constitution of the soil, will be illustrated further on.

Meteorology.—The very valuable and carefully prepared report of Dr. Sinks's upon this subject, will furnish abundant material compiled from reliable statistics, not only illustrative of the climatology of the State as bearing upon its agricultural resources, but furnishing the necessary data, to determine the atmospheric influences upon health. The tables of the report will be referred to again.

Prevalent Diseases.—The settlement of the State being so recent, (dating from the year 1855) no public measures have as yet been taken to collate statistics, showing the classes of disease, if any, which are engendered purely by the climatic and physical features of the State. The only sources from which any such information can be obtained at this time, or until a sanitary survey shall have been made, are first, the individual experience and records of medical men, and surgeons of posts, situated within the State, to the Surgeon General, and published in the statistics of the United States army. The information to be derived from the latter is of little value for this purpose, for two reasons: first, because such reports consist of mere topographical sketches of particular posts, together with observations made upon the diseases and mortality of soldiers congregated in barracks often under the worst hygienic influences—at all events, situated totally different from the civilian—soldiers who are ever upon the move, and who may have contracted the reported disease in some other locality; and, second, because the United States statistics are not the tabulated health statis-

tics of each individual post, but represent the diseases and mortality of a number of Forts aggregated together, though situated hundreds of miles apart, and under the most diverse features of climate and physical conditions. For instance, Kansas is classed in the middle interior region, west, and in this division are embraced, the Jefferson Barracks below St. Louis, the St. Louis Arsenal, and Forts Leavenworth, Scott, Riley and Atkinson in Kansas. Jefferson Barracks is situated in north latitude 38 deg. 28 min., and has an altitude of only 472 feet above the sea; while Fort Atkinson is in north latitude 37 deg. 47 min., and has an altitude of 2,330 feet above the sea level. The former is situated in the alluvial valley of the Mississippi, with its profuseness of rich vegetable decay, and the latter upon the sandy soil of the "great plains," with its sparse vegetation, almost entire absence of timber, and complete freedom from boggy marshes. The former has an elevation of 472 feet, the latter of 2,330 feet, a difference of 1,858 feet. The former is subject to the hot and humid winds, which sweep up from that great basin of tropical water, the Gulf of Mexico, while the latter enjoys the cooler and dryer winds which come from the regions west of the Gulf, and the Rocky Mountains. The utter dissimilarity in climatic and physical condition between these two posts, entail as wide a difference in the prevailing types of disease. The reflecting mind will see at once, that for the purpose of ascertaining the prevailing diseases of any particular region, the United States army statistics have no definite value.

In the following brief remarks concerning some of the more prominent diseases, supposed to be influenced by climate, individual observation and experience will be solely relied upon; owing to the discursive nature and purposes of this report, no effort will be made at any systematized nosological arrangement.

Fevers.—The class of fevers called malarious, periodical, autumnal, &c., prevail with different degrees of intensity in the great interior valley of North America. The nature of the specific cause producing these fevers, is still undetermined, but experience seems to unite upon the fact, that the cause

or causes are set into operation through the combined agencies of heat, moisture and vegetation, and (that within certain limits) the more fully these agencies exist, the more active is the causative principle and the more intense is its effect upon the system. Taking this fact as a basis, it would not be difficult, other things being equal, for the physician thoroughly acquainted with the physical geography of every portion of the great valley, its climatology, &c., to trace with a pencil the general line of development, and the relative degrees of intensity of the autumnal or periodical diseases.

In those sections of the valley, where from the nature of the soil, or the aspect and elevation of the surface, a thorough natural drainage is precluded, these fevers prevail (temperature also being favorable) with the greatest intensity. A wet soil is productive of a rank vegetation with its proneness to rapid decay; thus furnishing in profuseness one of the most essential elements of fever.

In addition to this influence of a wet soil in favoring vegetable growth and decay, the meteorological condition is most decidedly and insalubriously affected thereby. This is brought about by the excess of moisture with which the air is charged, whereby the secretions of the skin are impeded in direct proportion to the degree of saturation, and the internal organs are burdened to a greater or lesser extent, with the office of removing effete materials, which in health it is the function of the skin to eliminate. The damaging effects of a humid atmosphere upon the secretions, is much greater when combined with the influence of heat. The agency of the hot, wet atmosphere of the tropical regions, in producing in great intensity those diseases consequent upon a derangement of the secretary diseases, seem to decline in violence, in direct ratio to the subsidence of those conditions.

But upon the other hand, a moist atmosphere, if it be a *cool* one, as occurs in some of the higher latitudes, is equally productive of disease, though of a different nature, assuming more generally the shape of rheumatism, and pulmonary disorders, the latter being quite as fatal in their effects, as the diseases called into existence by heat and a high dew-point.

From these hasty observations, it will be seen that too great

moisture of soil is an important element in the causation of disease, and, in the valley, it gives origin to malarious fevers of a more or less benignant type, (the consideration of temperature being included,) as the facilities for its retention are present to a less or greater extent. Kansas, as said before, by reason of its physical aspect, its soil and its winds, is thoroughly drained. The streams usually have high banks and run in narrow channels, and the water is carried off with great rapidity. There is but little river bottom proper, and that which does exist is as readily drained by the facilities for percolation as the higher lands. Hence, no ponds or sloughs are found, and but rarely any springy soil. In Ohio, Indiana and Illinois, the streams generally flow through wide valleys, and have low banks, whereby the land is subjected to inundation; a subsoil tenacious in the highest degree, being usual to those localities, the water does not drain off with facility, and much of it is left to be evaporated, and assist in the production of malarial fevers. This is especially true in those portions of Indiana and Illinois shelving up to the great lakes. Extensive marshes or sloughs exist there, and the saturation of soil is so great that in seasons not remarkably dry, water is easily had a few feet below the surface. In these regions the fevers are of a very pernicious character at times, the "sinking chills" and "congestive fevers" being regular and dreaded visitants.

Kansas, enjoying such a surface drainage, should be exempt to a great extent from the violent malarious fevers of those regions. This is found to be the case. Intermittents and remittents of a mild character are incident to the vernal and autumnal months, but they yield readily to appropriate treatment, and leave behind but few of those shattering results ensuing from the more violent types. The pure congestive or pernicious variety of fever is a rare visitant in Kansas, except in a few of the most ill-favored localities. This being the case, it will readily be inferred that those forms assuming a typhoid aspect, and now designated typho-malarial, are not frequent.

To sum up, ague and bilious fever are the prevalent fevers of the spring and autumn months, but originally of a very

mild character, they are becoming more so, and less frequent, year by year, as population flows into the State.

All communities are subject to epidemic visitations, but the general salubrity or insalubrity of any particular region determines, to a great degree, the extent to which it shall suffer. In intensely malarious districts, the unwholesome influences keep the general health-rate below par; thus an open hand is extended to the epidemic influence, and large tributes are yielded to it. Such diseases as bad forms of diarrhœa, dysentery, erysipelas, measles, scarlet fever, small-pox, cholera, diptheria, spotted fever, &c., &c., commit great ravages when attacking the kind of population referred to. It will not be amiss to note the prevalence of these diseases in the order named, so far as they have been observed in Kansas:

Diarrhœa and Dysentery.—These have never assumed the epidemic form, and, but rarely, even a grave one. Both occur in June and July, as a consequence of the imprudent eating of unripe fruits and vegetables, and of the disturbing influences of heat upon the secretions. They, therefore, yield promptly to treatment.

Erysipelas.—Sporadic cases of a mild type occur. It has never prevailed in the State as an epidemic.

Measles.—Is frequent, being quite constantly imported by the immense throng of travelers continually in transit through the State. When occurring in winter, from the variations of temperature and carelessness in providing against them, serious complications sometimes arise in the lungs.

Scarlet Fever.—This disease has prevailed to a greater or less extent in the State at various times, but it has usually assumed a mild form, and the death-rate has been comparatively small. But few of the terribly malignant cases have been witnessed, the general tendency being to the benignant forms of the disease.

Small-Pox.—This has at various times been imported into the larger communities, but not to any great extent, its attacks being confined, in a great measure, to the habitats of filth.

Cholera.—During the years 1850, '51, '54 and '55, this disease prevailed among the troops at Fort Leavenworth, and along the great trail across the plains. In this, it but mani-

fested its usual propensity to attack communities, regardless of climate.

Diptheria.—This disease has been witnessed at varying times in the last few years, and has usually made its appearance in conjunction with a visitation of scarlet fever. There seems to be a strange relationship between these two diseases. In Kansas, they have seemed to occur together, and at times to appear vicariously with each other; their symptoms having been observed occasionally to merge. As was said of scarlatina, diptheria has only appeared (with a few exceptions) in a very mild and tractable form. Nothing of the terrible ravages of the disease, which have occurred in other communities, have been visited upon Kansas. The fatal cases which have occurred in Leavenworth and elsewhere, could, probably be found to be intimately associated with local or inherent constitutional causes, favoring the violent forms of any depressing disease. No registry law being in force in the State, it is impossible to arrive at the exact death-rate of this or any other disease. The experience of every physician will demonstrate to him, however, that it has been very small.

Spotted Fever.—Isolated cases of this disease have been reported. They have been, however, strictly isolated. It has never appeared in an epidemic form, carrying off whole families at a time. Individual cases of a violent type have occurred, and some have proven fatal; but these, when compared to the whole number attacked, prove the mortality to have been not great. The few cases of an unquestionable character, seen by the reporter, have been traced to a co-existence with local sources of insalubrity, or with an impaired constitution.

Rheumatism.—This disease may be said to be rare in the eastern part of the State, occurring generally in those with a constitutional tendency to it, called into action by exposure to bad influences.

It is one of those maladies, however, the susceptibility to which grows greater as we go westward to a greater altitude and a more rarefied air, obtaining its maximum intensity as the mountains are reached. This is true of all inflammatory diseases, and Kansas, by reason of her position in the Great

Valley, may be said to stand between those influences which propagate the malarious fevers east of the Missouri, and the inflammatory diseases of the mountain elevation: that is to say, while not exempt from disease, by any means, the energy of the one class is greatly spent upon reaching the eastern boundary, and the intensity of the other is not attained until a much greater western limit is found.

To complete this outline of those maladies which are influenced by climate and location, there yet remains a class of diseases of the first importance to be touched upon, the remarks upon which will close this report. The diseases of the *respiratory organs* is referred to.

It will appear from the tables of temperature prepared by Dr. Sinks, that Kansas is liable to great and sudden vicissitudes of heat and cold. This is true, to a greater or less extent, of the whole Interior Valley of North America. In Kansas, this result is probably due, in great part, to the winds. These, in consequence of the potent influence upon temperature exercised by the great western mountain chains, are liable to great variations in short spaces of time. The warm southwest wind, with its softening influences, may quickly veer round to the northwest, and come down in chilling blasts. There being no elevated objects to interpose and break the force of the winds, Kansas experiences them in all their force. Thus it is, that during the winter months, in a period of twenty-four hours, perhaps, the seasons are run into each other; the change being made from the warmth of a spring day to the biting cold of mid-winter.

It would appear from this, that people exposed to such influences would suffer greatly from diseases of the respiratory organs, such as inflammations of the larynx, the trachea, the bronchial apparatus, of the lungs, pleura, &c., &c.; and yet experience will demonstrate that although these diseases are of common occurrence in the winter months, that they do not mount up to a greater ratio than is usual in other portions of the Valley. The reason for this probably is, that the northwest wind is essentially a *dry* wind. When blowing, it feels pure, light and invigorating; oxydation of the blood is accomplished rapidly in the respiratory act, and the bad effects

which might otherwise ensue in consequence of the great reduction of temperature, are thus counterbalanced by the increased activity in the lungs.

Phthisis Pulmonalis, or Consumption.—The direction of the medical mind, in seeking for the causes of consumption, has, within a few years, been turned into a new channel. In the facts which have been accumulated concerning this dread disease, it has become apparent that *moisture*, either in the soil or atmosphere, has some occult influence in developing the malady. The limits of this sketch will only permit a bare allusion to the fact. It has been known for years that certain localities were remarkably exempt from consumption, and prominent among these are the regions in the far north, and the elevated regions of the Rocky Mountains. The inference is, that a dry, cold atmosphere is preventive of the disease. Kansas has a pure, dry atmosphere, and in this respect is more favorably circumstanced for preventing the development of consumption than any other portion of the Great Valley, east of the 94th meridian and south of the 45th parallel of north latitude.

These conditions of great dryness of atmosphere, however, increase as the mountains are approached, and hence the inference is, and experience confirms it, that the regions west of us are more fitted for preventing the development of the tubercular disease, than the region directly west of the Missouri river. Cases of consumption do occur in Kansas, but it is believed that they are among those exclusively with an hereditary predisposition to it; and even with these, the percentage of cases is much smaller than in the portions of the Valley named.

These hasty remarks complete the task assigned to the reporter. They are, as before said, a mere skeleton of the subject, presented simply for the purpose of leading to fuller action. If they shall accomplish that object, the whole aim of the report will have been consummated.

REPORT

ON THE

Climatology of Kansas,

BY

TIFFIN SINKS, M. D.

INTRODUCTION.

LEAVENWORTH, KANSAS, December 30, 1865.

PROF. G. C. SWALLOW, *State Geologist*:—

DEAR SIR:—I herewith submit my Report on the Climatology of Kansas. My design has been to collate the most important practical facts upon the subject, and state them in as concise language as possible. As this is to accompany your preliminary report, an exhaustive analysis has not been attempted.

Hoping that it will meet with your approval, and contribute somewhat toward placing Kansas in her true position,

I remain, very respectfully,

Your obedient servant,

TIFFIN SINKS.

DR. TIFFIN SINKS'S REPORT.

The agricultural resources of any country are largely dependent upon its climate, whatever may be the character of its soil. An early acquaintance, therefore, with tabulated observations, will save a considerable portion of the time and labor that would otherwise be expended in experiment.

The average results of meteorological observations for a series of twenty years, will vary but little from those for any greater series; the seasons traveling, apparently, in cycles of about twenty years each. By a wise provision of Government, meteorological observations have been made and recorded at all the military posts in the United States, since the year 1819. The measurements of rain, however, were not begun until 1836.

We have thus, in our early history as a State, a large fund of valuable information collected for us by disinterested parties.

The tables included in this report have been carefully arranged from the records of the United States Medical Department, and in some respects are as complete as is necessary for practical purposes.

The points selected for comparison, with the exception of Fort Kearney and Pittsburg, all lie within the same parallels that include the State of Kansas, are west of the Alleghanies, and are about equally exempt from, or exposed to, maritime influences. Their agricultural capabilities have been subject-

ed to practical tests for a long series of years, and the results are matters of statistical record.

By a comparison of meteorological records, (other things being equal,) we will arrive at both the relative and positive capabilities of Kansas.

Fort Kearney, although in Nebraska, is the farthest station west, and at the same time within the meridians that include the State of Kansas, at which observations have been made for any considerable period, and is, therefore, included in the table.

TABLE NO. 1.

Table of Mean Temperature for Months, Seasons and Years.

	Latitude	Longitude	Altitude—Feet	January	February	March	April	May	June	July	August	September	October	November	December	Spring	Summer	Autumn	Winter	Maximum	Minimum	Year
Fort Leavenworth	39°21′	94°44′	896	28°00	31°15	42°22	55°47	63°64	71°31	76°67	74°16	66°16	54°46	40°36	29°77	53°76	74°05	53°66	29°76	106°	—30°	52°81
Fort Riley	39.00	96.30	1,180	24.73	31.49	44.06	56.03	67.47	76.40	82.26	78.71	72.55	55.60	40.13	27.73	55.85	79.12	56.09	27.98	106	—23	53.47
Fort Scott	37.45	94.35	1,000	32.91	34.98	43.13	55.72	65.48	72.11	77.22	75.53	68.62	55.23	41.91	31.09	54.75	74.95	55.27	32.93	98	—10	54.48
Fort Larned	38.15	99.20	1,780	27.18	35.09	43.03	52.92	56.43	73.49	79.84	78.98	70.28	52.36	40.39	34.09	50.76	77.43	54.34	32.12			53.66
Fort Kearney	40.38	98.57	2,360	21.14	26.11	34.50	47.13	58.81	68.51	73.56	72.33	64.42	49.56	34.07	21.87	46.81	71.47	49.35	23.04	102	—28	47.66
St. Louis	38.40	90.05	450	31.44	33.43	42.30	55.08	65.07	74.20	78.22	76.16	69.58	54.20	42.55	31.93	54.15	76.19	55.44	32.27	107	—18	54.51
Cincinnati	39.05	84.29	500	33.50	34.10	43.40	54.50	63.50	71.10	76.30	73.70	65.50	53.00	42.30	33.80	53.80	73.70	53.60	33.80	106	—17	53.70
Pittsburg	40.32	80.02	704	29.25	31.16	39.02	49.96	60.92	69.22	72.98	71.21	63.58	50.91	39.80	31.35	49.97	71.47	51.43	30.59	100	—18	50.86

TOPOGRAPHY.

The State of Kansas lies between 37 and 40 deg. north latitude, and between 94 deg. 30 min. and 102 deg. west longitude. The eastern border is elevated 900 feet above the level of the sea, and gradually ascends toward the west at the rate of about three feet per mile. The surface is that of gently undulating prairie, interspersed with numerous streams, the margins of which are skirted by timber.

The general direction of the principal streams is from west to east.

The eastern half of the State is abundantly supplied with timber for all practical purposes; from Fort Riley to the western border it rapidly diminishes, both in amount and quality. There is nothing in the vertical configuration that would, in any degree, influence the local climate. Uniformity in character and appearance is patent to the observer. Extending through three degrees of latitude, a corresponding difference would be expected between the temperature at the northern and southern borders, during the spring and autumn months.

The intrusion of the Great Plains on the west exerts a marked influence upon the climate, the details of which will be given in their appropriate place.

The natural drainage of the State is most excellent, the descent of the beds of the streams being sufficiently great to produce rapid currents.

There is an entire absence of lakes, swamps, or marshes, and the streams seldom overflow the alluvial bottoms along their course.

TEMPERATURE OF THE THREE MONTHS OF SPRING.

The thermal calculations, in Table No. 1, are made from mean quantities only, as being the best approximation to positive and unalterable quantities, as well as contributing to brevity.

The distribution of heat for the three months of spring, at all the points mentioned, is characterized by great variability in successive years, as well as constant differences of the months, but the advance in mean temperature from March to

April, and from April to May, is quite uniform for any one season.

March is sometimes a full winter month, and May a full summer month; but this so seldom occurs that it may be called an exception. In these instances compensation is usually made by an early or late winter in the same year.*

The course of the isothermals, for the season as a whole, in reference to the points included in the above table, varies but slightly from the parallels of latitude, and practically may be considered the same. Similarly, the monthly increase of heat from March to April, and from April to May, is the same, being an increase of about ten degrees for each month. The irregular non-periodic distribution of heat shows a marked difference, the extremes being greater in Kansas than in any of the States further east.

This is perhaps due to the influence of the plains. The breezes sweeping down the slopes of the Rocky Mountains, having an unopposed transit across the intervening country, expend their chief influence upon Kansas. Another fact, and one that cannot be expressed in tabular form, is, that during this season the transitions of temperature are sudden as well as great.

This is a feature of great practical importance to the Kansas farmer, especially to the horticulturist, and deserves a full expression.

It is not only important to know the mean temperature for each month, but, also, the greatest variation above and below the mean; to what extent we may expect the thermometer to fall, at any single observation, in each of the spring months, and the very highest and lowest point possible to be attained in a series of years.

The following tables exhibit this distribution of temperature.

* The month of March, 1865, was a full winter month, and the succeeding September a full summer month.

TABLE NO. 2.

General Range of Mean Temperature.

	MARCH.					APRIL.					MAY.					
	Highest Mean Temperature	Lowest Mean Temperature	Range	Date of Maximum	Date of Minimum	Highest Mean Temperature	Lowest Mean Temperature	Range	Date of Maximum	Date of Minimum	Highest Mean Temperature	Lowest Mean Temperature	Range	Date of Maximum	Date of Minimum	Number of y'rs Observed
Fort Leavenworth	53°4′	17°4′	36°0′	1842	1843	64°0′	45°0′	18°9	1839	1850	67°1′	59°3′	7°8′	1833	1837	34
Fort Riley	52.4	38.1	14.3	1860	1856	63.4	53.3	10.1	1855	1862	73.3	59.9	13.4	1860	1857	10
Fort Kearney	45.7	31.7	14.0	1860	1850	54.3	37.7	16.6	1855	1857	65.4	53.5	11.9	1860	1853	16
Fort Scott	49.3	24.5	24.8	1849	1843	63.2	48.5	14.7	1844	1850	69.5	61.5	8.0	1851	1847	10
St. Louis	57.8	25.5	33.2	1842	1843	65.6	48.5	17.1	1845	1850	73.7	57.5	16.2	1829	1838	27
Cincinnati	52.5	28.8	23.7	1842	1843	64.2	48.3	16.9	1844	1837	67.0	56.7	10.3	1846	1838	24
Pittsburg	46.7	26.0	20.7	1842	1843	59.5	44.4	15.1	1844	1852	65.4	53.9	11.5	1842	1850	27

Table No. 2 exhibits the highest and lowest mean temperature ever observed for each of the spring months, the range and the dates of each. For those points at which records have been kept for twenty years in succession, they probably express as great extremes as will ever again occur.

TABLE NO. 3.

	MARCH.		APRIL.		MAY.	
	Mean Maximum.	Mean Minimum.	Mean Maximum.	Mean Minimum.	Mean Maximum.	Mean Minimum.
Fort Leavenworth	73°	13°	81°	28°	85°	41°
Fort Riley	77	15	87	27	89	43
Fort Kearney	70	7	80	21	86	32
Fort Scott	73	13	82	29	86	39
St. Louis	73	16	84	30	87	44
Cincinnati	69	19	82	31	84	41
Pittsburg	67	12	77	23	84	36

Table No. 3 exhibits the mean maximum and minimum temperature, calculated from the extremes of each month for the whole number of years. The measures are those that may be expected at some period in each month for any year.

TABLE NO. 4.

	MARCH.				APRIL.				MAY.			
	Maximum.	Minimum.	Date of Maximum.	Date of Minimum.	Maximum.	Minimum.	Date of Maximum.	Date of Minimum.	Maximum.	Minimum.	Date of Maximum.	Date of Minimum.
Fort Leavenworth	85°	-4°	1852	1843	96°	15°	1855	1854	90°	32°	1850	1850
Fort Riley	85	5	1854	1855	95	18	1855	1857	99	37	1856	1857
Fort Kearney	82	-4	1853	1857	92	10	1855	1857	94	26	1856	1851
Fort Scott	87	-10	1852	1848	87	22	1843	1851	90	31	1852	1851
St. Louis	85	0	1845	1848	94	17	1845	1857	92	32	1845	1851
Cincinnati	76	4	1851	1858	89	21	1855	1857	90	31	1857	1851
Pittsburg	82	-4	1848	1856	86	18	1844	1855	90	28	1846	1851

Table No. 4 exhibits the greatest and least temperature ever observed, and the date of each. As in Tables Nos. 2 and 3, the range in Kansas is decidedly greater than in the other States represented.

The simple fact that a low degree of temperature may be reached during any of these months, is, of itself, unimportant, but when coupled with the fact that the transition from high

to low, and the reverse, may be both great and sudden, it becomes of peculiar interest, and should always be considered as a possible occurrence, any year, to be guarded against.

It is a common practice, in the Eastern and Middle States, to plant orchards and vineyards upon southern slopes.

This is bad practice in Kansas, for the reason that the sap is stimulated too early in the spring, and the trees and vines exposed to these sudden depressions of temperature during the most critical period in their existence. By reversing the process, and planting vines and fruit trees upon high northern exposures, the circulation of the sap is retarded, and the danger materially lessened. The summers are abundantly warm and long to fully mature the fruit. The best evidence of the correctness of the above consists in the experience of fruit growers in Western Missouri. The orchards in that region, upon high northern exposures, are not only more hardy, more productive, and longer lived, but also more certain to produce each year than where southern exposures are selected. Another fact bearing upon this point is, that the trees affected by these transitions of temperature invariably show the blight upon the southern side.

By reference to Table No. 3 it will be observed that the mean maximum temperature for March is 73 deg., and the mean minimum 13 deg., giving a range of 60 deg. that may be expected any year. During the month of March, 1852, the greatest temperature was 85 deg., and the least, 16 deg.

A variation of 40 deg. from noon until midnight is not an infrequent occurrence during this month.

These peculiarities of climate are fixed and definite, and however much the early buds may promise, a killing frost will frequently come to disappoint the hopes. The limiting period for frosts in Kansas is the last of May.

They so seldom occur, however, after the 15th of this month, that this date may be practically considered the frost limit. The distribution of temperature for these months being of vastly greater importance than for any other months, a full expression has been given to all the prominent features.

DISTRIBUTION OF HEAT FOR THE THREE MONTHS OF SUMMER.

An analysis of the thermal distribution for each of the summer months is quite unnecessary, for the reason that during neither of them is there sufficient elevation or depression of temperature to destroy vegetation. In Table No. 1 the thermal mean is given for each. The mean for the season is 74 deg. for the eastern border of the State, with a slight progressive increase to about the 97th meridian, where it is 98 deg. From this point the isothermal bends pretty sharply towards the south.

During this season, the extremes of temperature reverse their order in the spring months, and show a preponderance above rather than below the mean.

The isothermals of 70 and 75 deg. include the States of Iowa, Illinois, Indiana, Ohio, Kentucky, Upper Tennessee, Virginia, Maryland, Delaware, Pennsylvania and New Jersey. The State of Kansas shows a little higher temperature than either of these. This is perhaps due to the influence of the Plains.

The radiation of heat from this immense surface, and particularly from the sandy region southwest of the Arkansas river, produces a marked effect upon the atmosphere, which, when circumstances are favorable, is felt as far east as the Mississippi river. On the 9th of July, 1860, from 10 o'clock in the morning until 6 o'clock in the evening, a dry hot wind blew from the southwest, varying in temperature from 108 to 112 deg. Fahrenheit. A similar hot wind came from the same quarter September 2d, 1864.

This temperature, however, was only manifested when the thermometer was exposed to the direct current of air. During this time the clouds were traveling in an exactly opposite direction, and apparently quite low.

The lower hot stratum had evidently traversed a considerable distance, accumulating heat in its march, without having found a break in the upper stratum through which to pass and distribute its excess of heat.

In respect to temperature, the summer in Kansas is four months in duration rather than three: beginning usually

about the 15th of May and extending to the 15th of September. The daily mean temperature for the month of September, 1865, did not fall, at any time, below 70 deg.

DISTRIBUTION OF TEMPERATURE FOR THE AUTUMN MONTHS.

The thermal mean for the autumn months, as a whole, is of much less practical importance than that of each month separately, and therefore particular mention will be made of single limiting temperatures, with reference to their effect upon vegetation.

The mean for the season will be found in Table No. 1. By reference to this table it will be observed that the mean temperature for this season conforms more strictly to the lines of latitude than that for any other season of the year.

In the following table the mean maximum and minimum temperature are given for each month, as an expression of what may be expected any year.

TABLE NO. 5.

Mean Maximum and Minimum Temperature.

	SEPTEMBER.			OCTOBER.			NOVEMBER.		
	Maximum.	Minimum.	Range.	Maximum.	Minimum.	Range.	Maximum.	Minimum.	Range.
Fort Leavenworth	90°7	44°1	46°6	83°0	27°4	55°6	67°5	14°5	53°0
Fort Riley	94.6	44.6	50.0	82.6	32.0	50.6	69.0	14.5	54.5
Fort Kearney	83.1	34.0	49.1	84.4	19.8	64.6	63.4	9.0	54.4
Fort Scott	92.1	40.7	41.4	84.4	27.8	56.5	72.8	15.7	57.1
St. Louis	93.3	43.6	49.7	81 5	30.0	51.5	68.5	20.7	47.8
Cincinnati	88.6	48.8	39.8	77.5	33.7	43.8	68.5	26.8	41.7
Pittsburg	87.3	41.3	46.0	73.5	29.0	44.5	64.0	18.5	43.5

The decline in mean temperature from September to October and from October to November, is quite uniform, being about 12 deg. for each. There is an almost exact accordance, in mean temperature, for the months of March and November, April and October, and May and September. The range, however, is much greater for each of the spring months. November, like March, is characterized by sudden transitions in temperature.

At 12 A. M., November 25th, 1864, the sun was shining brightly, and the thermometer stood at 50 deg. At half-past

twelve the wind suddenly veered to the northwest, and swept down with a freezing temperature. At 12 P. M., the mercury had descended to 4 deg. above zero.

These sudden transitions during March and November are common to all the temperate latitudes, but they are much greater and more frequent in Kansas than in the States east of the Mississippi river.

The single extremes may be stated in general terms, without resorting to a tabular form, and as they are only of importance for the month of September, will not be given for either of the other months. In 1844 and 1851 frosts were observed at each of the localities in the above table on the 25th of September. The occurrence of destructive frosts during this month are very rare, however; but after this month they may be expected at any time. November is the only month that shows a mean minimum temperature of 32 deg.

TEMPERATURE FOR THE WINTER MONTHS

A minute analysis of the distribution of temperature for the winter is not of material importance to the agriculturist. For the purpose of comparison, however, the mean temperature for each of the months and the season is given below:

TABLE NO. 6.

MEAN TEMPERATURE FOR THE WINTER MONTHS.

	Dec.	Jan.	Feb	Sea'n
Fort Leavenworth	29°77′	28°00′	31°15′	29°64′
Fort Riley				
Fort Scott	31.09	32.91	34.98	32.93
Fort Larned	34.09	27.18	35 09	32.12
Fort Kearney	21.87	21.14	26.11	23.04
St. Louis	31.93	31.44	33.43	32.27
Cincinnati	33.80	33.50	34.40	33.90
Pittsburg	31.35	29.25	31.16	30.59

It will be observed, by reference to the foregoing table, that the average temperature for the winter in Kansas is a little below that of the States further east, and that there is a gradual reduction in the State itself from the Missouri river westward.

The range is very great and the position of the minimum, with reference to a particular month, very irregular in any winter.

The greatest degree of cold is just as likely to occur in

one month as another, as is shown by the close resemblance of the means for each.

While extreme depressions of temperature are common to this season, the winters are not continuously cold. The mercury rarely remains at or below zero, of Fahrenheit, for a longer period than three days in succession.

The foregoing analysis discloses the fact that in all essentials the temperature of Kansas is the same as that of the States of Missouri, Illinois, Indiana, Ohio and Pennsylvania, and that as far as the temperature alone is concerned, is adapted to the same productions.

DISTRIBUTION OF RAIN.

The precipitation of rain for the seasons and years in Kansas is invested with peculiar interest, and a corresponding effort has been made to indicate clearly its character. Unfortunately for the State much has been said and written upon this subject that will not bear the test of investigation. Individual opinion is so largely dependent upon success or failure in any enterprise or location that it is utterly unreliable. The following table has been carefully arranged from the records of all the observations made at the military posts within the State, extending to the year 1865.

For the stations not within the State, the records accessible are to the year 1860, except Fort Kearney, which extends to 1864.

The number of years during which observations were made, are given for each locality. A fuller expression might be given by including in the table the amounts for each month and year, but the consolidated results, as given, are deemed sufficient for the present purpose. Those who are curious can examine the records as published by Government. The amounts are expressed in inches and hundredths. The measure of snow is made after it has been melted.

TABLE NO. 7.

Mean Precipitation of Rain, Calculated for Seasons and Years.

	Spring.....	Summer.....	Autumn.....	Winter.....	Year.....	No. Years.
Fort Leavenworth	7.32	13.03	7.57	3.42	31.34	30
Fort Riley	5.62	10.68	5.87	2.72	24.90	5
Fort Scott	12.57	16.37	8.39	4.79	42.12	10
Fort Larned	5.36	8.45	4.01	.81	8.63	4
Fort Kearney	6.80	10.62	4.85	1.50	23.77	13
St. Louis	12.30	14.14	8.94	6.94	42.32	19
Cincinnati	12.14	13.70	9.90	11.15	46.89	20
Pittsburg	9.38	9.87	8.23	7.48	34.96	18
Athens, Illinois	12.20	13.30	9.20	7.10	41.80	10

The measure of moisture, precipitated in rain and snow, for the entire year, in Kansas, is very considerably below that for the other States represented in the table. By comparing the measurements for the spring, summer and autumn months, however, it will be found that the difference is very slight.

The winter months show a great dimunition in the relative amount, but as the deficiency occurs during the absence of vegetation, it is of no practical importance. As a consequence, the roads during this season are usually dry and in splendid condition for travel, thereby rendering transportation easy at the very time the farmer desires to send his heavy produce to market.

The advantages of a dry winter to the stock raiser are undoubtedly very considerable, but the limits of this article do not admit of a detailed investigation. Experience has demonstrated the fact that cattle will subsist throughout the winter upon the prairies alone.

The precipitation of rain for the month of March shows a small increase over the winter months. The quantities are doubled in April, and again doubled in May. The mean maximum occurs in June, and the mean minimum in January.

The greatest amount in one year ever observed at Fort Leavenworth was 59 inches, in 1858; the least amount was 16 inches, in 1843. The greatest at Fort Scott was 62 1-2 inches, in 1844; the least was 29 inches, in 1848. No records were kept at Fort Scott during the year of 1860, but the amount for the summer months was undoubtedly less than at Fort Leavenworth, as was evidenced by vegetation. The

deficiency of rain at Fort Leavenworth in 1843 must have been local, as the records at Fort Scott for the same year show a measurement of 44 inches. Besides, the Indians living in the Territory at that time have no recollection of a drought of a general character.

The amount of snow that falls during the winter is usually very slight, and it remains on the ground but a short time.

As affecting the general routes of transit across the plains, it may be of interest to state that, both as regards the depth of snow falling at one time, and the length of time during which it remains upon the ground, the Smoky Hill route possesses great advantages over any other.

Taking the records at Forts Leavenworth, Riley and Scott as a basis for calculation, the mean annual precipitation of rain for the eastern half of the State is 32 78-100 inches. The mean for the western half is about 24 inches.

The mean for Minnesota is 30 inches, for Wisconsin, 32 inches, and for Michigan, 30 inches.

The drouth of 1860, occurring as it did when the people were poor, and when even under the most favorable circumstances, the productions were not equal to the home demand, became quite notorious, and cast a doubt upon the agricultural capacities of the State that will require years to dispel. A false notion or opinion once adopted is clung to with remarkable pertinacity, for the reason that but few will take the trouble to investigate for themselves.

Lorin Blodget, in his admirable work on the Climatology of the United States, says that "for all portions of the United States east of the Rocky Mountains, the distinguishing features of the distribution of atmospheric precipitation in rain are its symmetry and uniformity in amount over large areas, and in its having a greater amount in the interior than on the coasts for the same latitude, at least as far north as the 42d parallel of latitude. The non-periodic variations of quantity, however, are very great, and, for most of the area, the range, even for a period of three months, may descend to an entire absence of rain, and for single months this entire absence is quite frequent."

Arnold Guyot, in his lectures on Physical Geography,

says: "One of the most characteristic features of the climate of the United States, consists in that changeableness—that extreme variety of temperature, of fair weather and of foul—that uncertainty of the seasons which always keeps the farmer in anxious suspense between the hope of a good harvest and the fear of a drouth."

The above quotations, from men who stand deservedly high in walks of science, are made for the purpose of showing, without entering into details, that the whole area embraced by the temperate zone in North America is subject to drouth.

In 1860, the relative deficiency of rain was quite as great in Southern Missouri, Arkansas and Western Tennessee as in Kansas. In 1854 a general drought prevailed in all the Central States, from the Missouri river to the Atlantic coast.

The following tabular statement will give a better expression of its extent and character than if made in general terms. The statistics are for the summer months only, as this is the period of greater importance in the supply of rain. The drought, however, continued throughout the autumn months, in most of the localities.

	Summer of 1854—inches.	Average for Sum—Inches.		Summer of 1854—inches.	Average for Sum—Inches.
Fort Leavenworth	5.7	13.0	Pittsburg	4.7	9.8
Fort Riley	2.7	10.6	Washington	4.8	12.0
Fort Smith, Ark	4.1	13.9	Norfolk, Va	3.5	15.1
St. Louis	5.4	14.1	New York	5.1	11.5
Cincinnati	6.2	13.7	Burlington, Vt	5.1	10.8

A drought so widely extended as that of 1854, is a rare occurrence in this climate. They are usually confined to a much smaller compass, and, at such times, the neighboring districts are supplied with an excess of rain. While a drought is by no means a desirable occurrence, an excess of rain is equally injurious. The general proposition, that the whole Mississippi valley is more damaged in its grain and root crops by an excess of rain than from a deficiency, will scarcely be questioned.

The exact measure of rain, for the seasons and the year, required for the highest productive development, is exceed-

ingly difficult, if not impossible, to determine for any considerable area. In fixing the quantity for any locality, the character of the soil enters largely into the calculation. As compared with that of the States of Ohio, Pennsylvania and Kentucky, the soil of Kansas requires a less measure of rain to develop its full productiveness.

Prof. Swallow, in his able report, has admirably described its character, qualities, and the peculiarities of its formation. Suffice it here to say that it is light, porous and deep, is readily permeated by moisture, and as readily yields it to the demands of vegetation. The heavy, impervious clay subsoil, common to all the uplands in the States above mentioned, are found here only in very limited areas. Nature, always compensatory, has made equivalent provision for any defects in the relative amount of rain, by spreading, broad-cast over the State, a soil unsurpassed in fertility.

WINDS.

The geographical position of the State—its proximity to the plains—its exposure to the cold currents from the Rocky Mountains and the warm ones from the Gulf of Mexico, the conflict of these with the great normal west wind of the temperate latitudes, all combine to produce confusion from which it is almost impossible to eliminate anything that may be called general. All points of the compass are represented, and quite frequently, during the same day.

The prevailing winds in the summer are from the southwest, south, and southeast; in the winter, from the northwest, north, and northeast, in the order of frequency as enumerated. During the spring and autumn these points are about equally represented. Direct east or west wind, except of a fitful character, are quite infrequent. A continuous south wind for three days in succession is almost invariably followed by rain. The rain, however, is usually precipitated by a reverse current, and the change in the direction of the wind, just preceding the fall of rain, is quite sudden.

The average force of the winds is greater than that for the Central States, east of the Mississippi, and they are also more constant.

The foregoing is a brief statement of the important practical facts in reference to the positive and comparative Climatology of Kansas. From November to March, inclusive, the transitions of temperature are greater in range, more sudden and more frequent than in the Central States, east of the Mississippi river.

This is the characteristic difference, and the only one of any importance. As it chiefly affects the cultivation of fruit, measures of precaution should be taken, both in the selection of hardy varieties and in the location of orchards and vineyards.

For the eastern half of the State, the measure of rain, excepting for the winter, is quite equal to that of Pennsylvania and New York, and is amply large for all the requirements of an exuberant vegetation. West of the 98th meridian, there may reasonably be some doubt as to the sufficiency. The amount for the summer, however, is quite large, and compared with the European plains in like geographical position—those of Eastern Germany and Russia—which sustain a large population, the difference is decidedly in favor of the plains of Kansas.

The valleys of the Arkansas, Smoky Hill, Solomon, Republican, and their branches, are peculiarly rich in grasses, which would seem to be decisive of the general question of the sufficiency of rain.

When this region shall have been reclaimed from the dominion of the wild buffalo and wilder Indian, its productive capacity will be found to be far beyond that accorded to it by geographers. The resistless western march of the hardy pioneer, and the commercial demands for an iron bond connecting the Atlantic and Pacific, will soon crowd them from their haunts, and not entirely imaginative will be the bright picture of quiet homes, cultivated fields, grazing herds and a teeming population spread over the fabled arid plains of Kansas.

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